EROSION HAZARD
OF MINNESOTA'S LAKE SUPERIOR SHORELINE

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INTRODUCTION

The rugged beauty of bedrock cliffs rising from the waters of Lake Superior creates a memorable impression of Minnesota's Lake Superior coast. But unlike the resistant bedrock that creates beautiful vistas, some sections of the Minnesota shoreline are erosive sand or clay banks. Buildings and roads built in these areas are threatened by the gradual wearing away of the coast by the powerful waves of Lake Superior.

While shoreline erosion can only be prevented at great expense, economic losses are minimized by knowing where and how fast shoreline erosion is likely to occur. Future problems are avoided by locating new structures and septic fields back from the bluff line to allow for the erosion that is expected to occur. Fortunately, the Minnesota Lake Superior shoreline has had relatively little development in comparison to other Great Lakes shorelines, so good planning can prevent future problems.

There are several ways to identify erosion hazard areas. On-site monitoring of erosion is the most precise way to measure short-term erosion rates, but can be misleading as an indicator of long-term hazard if unusual conditions during the monitoring period cause uncharacteristically high or low erosion rates. Measuring shoreline recession from a time sequence of maps or aerial photos provides longer-term erosion rates. Shoreline geology also provides an indication of erosion hazard, because some types of geologic materials are more resistant to erosion than others. This study combined the latter two methods to produce maps of long-term shoreline erosion potential.

Long-Term vs. Short-Term Erosion

Shoreline erosion does not occur at a constant rate, because the factors that cause erosion are continually changing. Lake Superior can be as smooth as glass one day, and have 20 foot high waves another. The waves that reach the Minnesota shoreline are highest during storms with strong easterly winds. Erosion of beaches and the base of bluffs is most rapid during these storms.

In shorelines with clay soils, erosion can occur as a large block of material breaking off and slumping down toward the lake, often during storms. The short-term erosion rate in this case is equal to the size of the slump block measured perpendicular to the shore, but the long-term erosion rate is equal to the width of the slump block divided by the number of years between slumpages. If slumping occurs infrequently at that location, the long-term erosion rate would be small, even when the short-term erosion is large. Placing a heavy load on the soil surface, such as a building, increases this type of erosion.

Rainfall erodes sloping bare soil, and causing gullies to form. Gully erosion can be rapid in localized areas, and is hard to stop once started. Surface and gully erosion is highest during intense rainfall, especially when the ground is already saturated or where water moves slowly into the soil. When the soil becomes super-saturated, mud flows occur. Leaking septic fields can worsen this situation.

All of these short-term erosion factors add up to long-term shoreline recession, the gradual landward movement of the shore. This study measured long-term recession of the Lake Superior shoreline by comparing shoreline location on aerial photos taken 14 years apart or more.

How Was Erosion Hazard Determined?

Shore location was determined at selected sites using aerial photographs taken in the 1930s, 1975, and 1988/89. The distance over which the shoreline receded during the time period between air photo dates was divided by the number of years between photos to figure an annual erosion rate for these sites. Recession rates below the detection limits of the measurement method used were marked as "BD" (below detection). Values less than 0.3 ft/yr were below detection limits for the 1930s-1975 time period, and values less than 0.6 ft/yr were below detection for the 1975-1988/89 time period.

The recession rates were statistically compared with coastal characteristics, and the presence or absence of bedrock was found to be the best predictor of erosion. Non-bedrock areas (glacial deposits, post-glacial beach deposits, clay bluffs, peat deposits) had the highest erosion rates, even when they overlaid bedrock at the shoreline. Although clay bluffs were expected to have the highest erosion rates, post-glacial sand & gravel beach deposits were equally erosive. The highest erosion rates measured for both time periods occurred in a sand & gravel deposit (T61N, R3E: map 31). Clay bluffs are most common between Duluth and Castle Danger (maps 1-9), while post-glacial sand & gravel deposits are most common in Cook County. Some types of thinly-layered bedrock were also subject to erosion and sea cave formation.

Based on these relationships, maps of shoreline surficial geology published by the Minnesota Geological Survey were used to classify erosion hazard. Sites with any of the following geologic types occurring within sixty meters of the shoreline were classified as "high erosion potential": organic deposits, sand & gravel, clay & silt, unsorted glacial deposits.

Because the factors that influence long-term recession vary over time, recession rates may also vary. For example, map 2 contains three sites at which recession was measured over both time periods. Although two of the sites had high erosion rates during 1939-1975 (0.69 and 0.81 ft/yr), erosion at these sites was below detection (<0.6 ft/yr) in 1975-1989. In contrast, a site southwest of the Split Rock River (map 11) had lower average annual erosion between 1939 and 1975 than it did between 1975 and 1989. These findings illustrate that while we can predict relative erosion hazard, exact erosion rates are impossible to predict.

WHAT DO THE MAPS SHOW?

The 39 maps in this publication show erosion hazard potential for the Minnesota North Shore from Duluth to the Canadian border. Each map shows about 4 miles of shoreline, classified into one of the following three erosion potential categories:

- **High.** These shoreline areas have high potential for erosion because they have non-bedrock areas at or near the shoreline. Measured erosion rates during the 1930s-1975 averaged 0.46 ft/yr in these areas, and were as high as 1.1 ft/yr (Table 1). Nearly all detectable erosion during the 1975-1988/89 period occurred in these areas, with a maximum measured value of 4.5 ft/yr (see map 31).

- **Low.** These shoreline areas have low potential for erosion because they are predominantly resistant bedrock. Erosion rates during the 1930s-1975 averaged 0.16 ft/yr in these areas, but measured values were as high as 0.64 ft/yr (Table 1).

- **Unknown.** These are areas of artificial shoreline, such as Taconite Harbor (see Map 20), or areas west of the Lester River in Duluth for which there were no geologic maps.

Measured erosion rates in feet/year are shown by the open triangles (△) for the 1930s-1975 time period, and closed (▲) triangles for the 1975-1988/89 time period. Other features shown include place names, township, range, and section numbers, major and minor roads, railroads, and rivers and streams. The maps also contain information about erosion hazard areas designated by county and regional management groups (see section on Erosion Hazard Zoning).

Table 1. Average and maximum recession rates measured, 1930s-75, ft/yr.

	Average	Maximum
High Erosion Potential	0.46	1.09
Low Erosion Potential	0.16	0.64

Erosion Hazard Zoning

The North Shore Management Plan (NSMP) was developed by a joint powers board consisting of county, city, and township governments to provide environmental protection for and guide the orderly growth of the North Shore of Lake Superior. The plan is intended to improve state mandated shoreland management regulations, and includes erosion hazard guidelines "to protect public and private property and protect private interest and safety by guiding development in areas prone to excessive shoreline erosion." It defines Erosion Hazard Areas as "those areas of Lake Superior's North Shore where the long term average annual rate of recession is one foot or greater per year." The plan includes a general guide map indicating erosion hazard areas for use by local zoning authorities in adopting, amending, and administering local zoning ordinances. Only those areas deemed to be of high potential for erosion were put on the guide map, which except in cases was limited to the areas where high clay banks border the lake. These areas have been noted on maps 2,3,4,6,7,8,9,10,11,17,18,33, and 34 of this brochure.

In preparation for adopting zoning regulations consistent with the the North Shore Management Plan, Lake County conducted field studies of areas thought to be erosion prone. Thes areas have been noted on maps 6,7,8,9,10,11,17, and 18 of this publication.

FOR MORE INFORMATION

For more information about shoreline erosion and what you can do to minimize it, contact any of these agencies:

Minnesota Sea Grant Extension Program
208 Washburn Hall
University of Minnesota
Duluth, MN 55812

Minnesota Board of Water and Soil Resources
394 S. Lake Avenue
Duluth, MN 55802

U.S. Soil Conservation Service
4850 Miller Trunk Highway
Duluth, MN 55811

Soil & Water Conservation District
Lake County Courthouse
Two Harbors, MN 55616

For more information about the North Shore Management Plan, contact:

North Shore Management Board
330 Canal Park Drive
Duluth, MN 55802

For more information about shoreland zoning regulations, contact:

St. Louis County Health Department
222 E. Superior Street
Duluth, MN 55810

Lake County Zoning & Health Department
Lake County Courthouse
Two Harbors, MN 55616

Cook County Zoning Department
Cook County Courthouse
Grand Marais, MN 55802

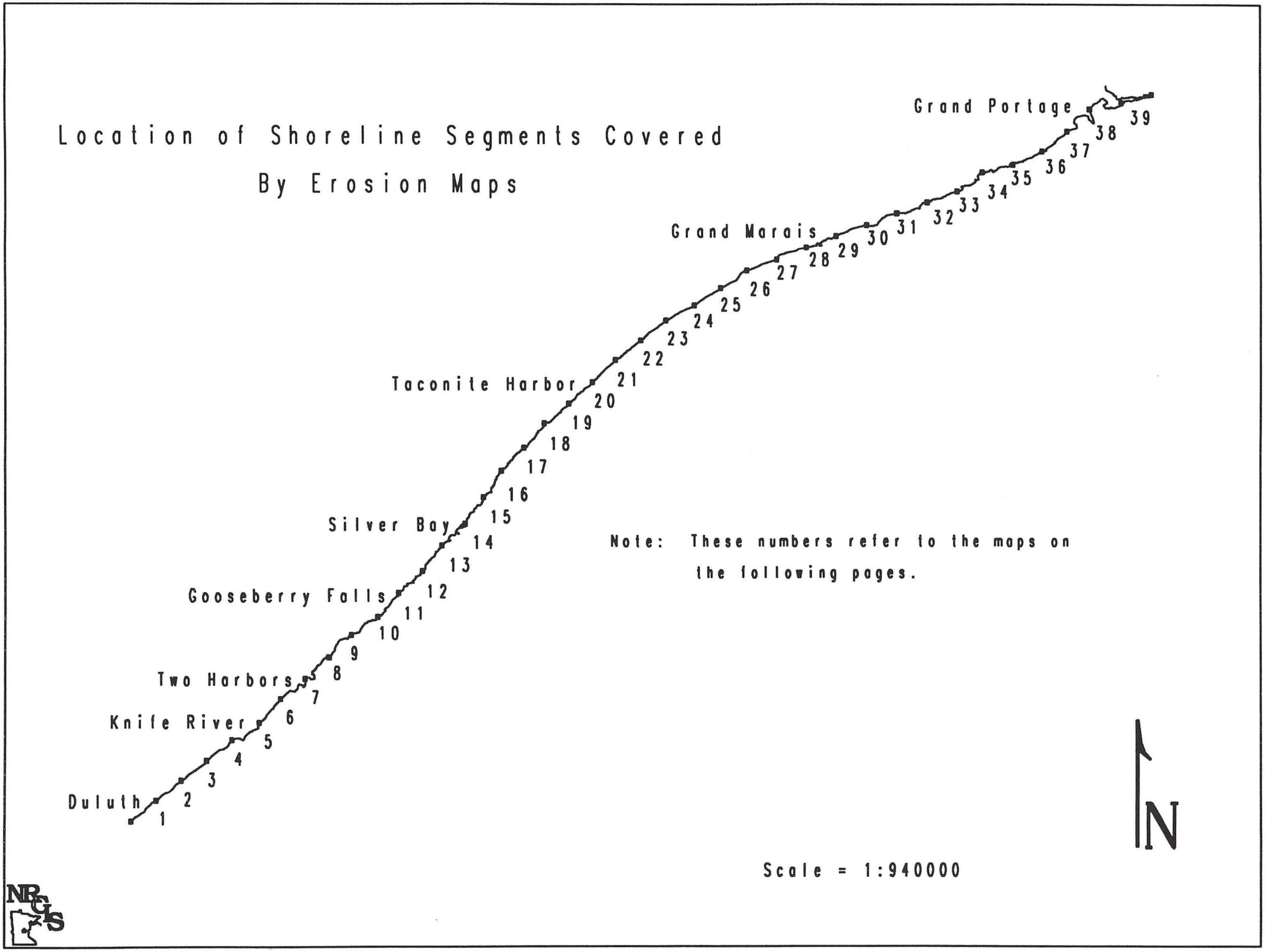
Minnesota Department of Natural Resources
Duluth Area Hydrologist
5351 North Shore Drive
Duluth, MN 55804

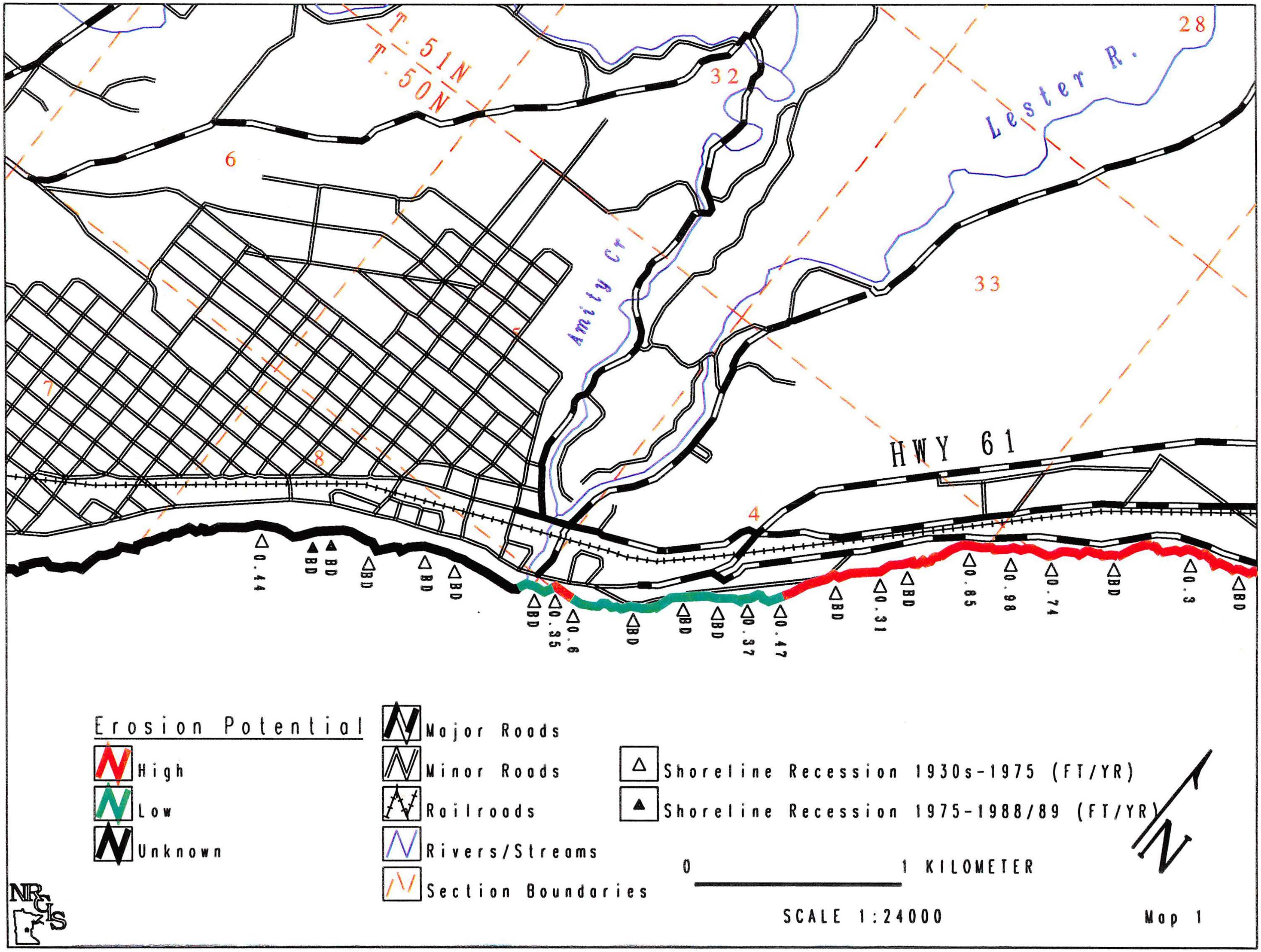
References

North Shore Management Plan. North Shore Management Board, 1988. 50 pp.

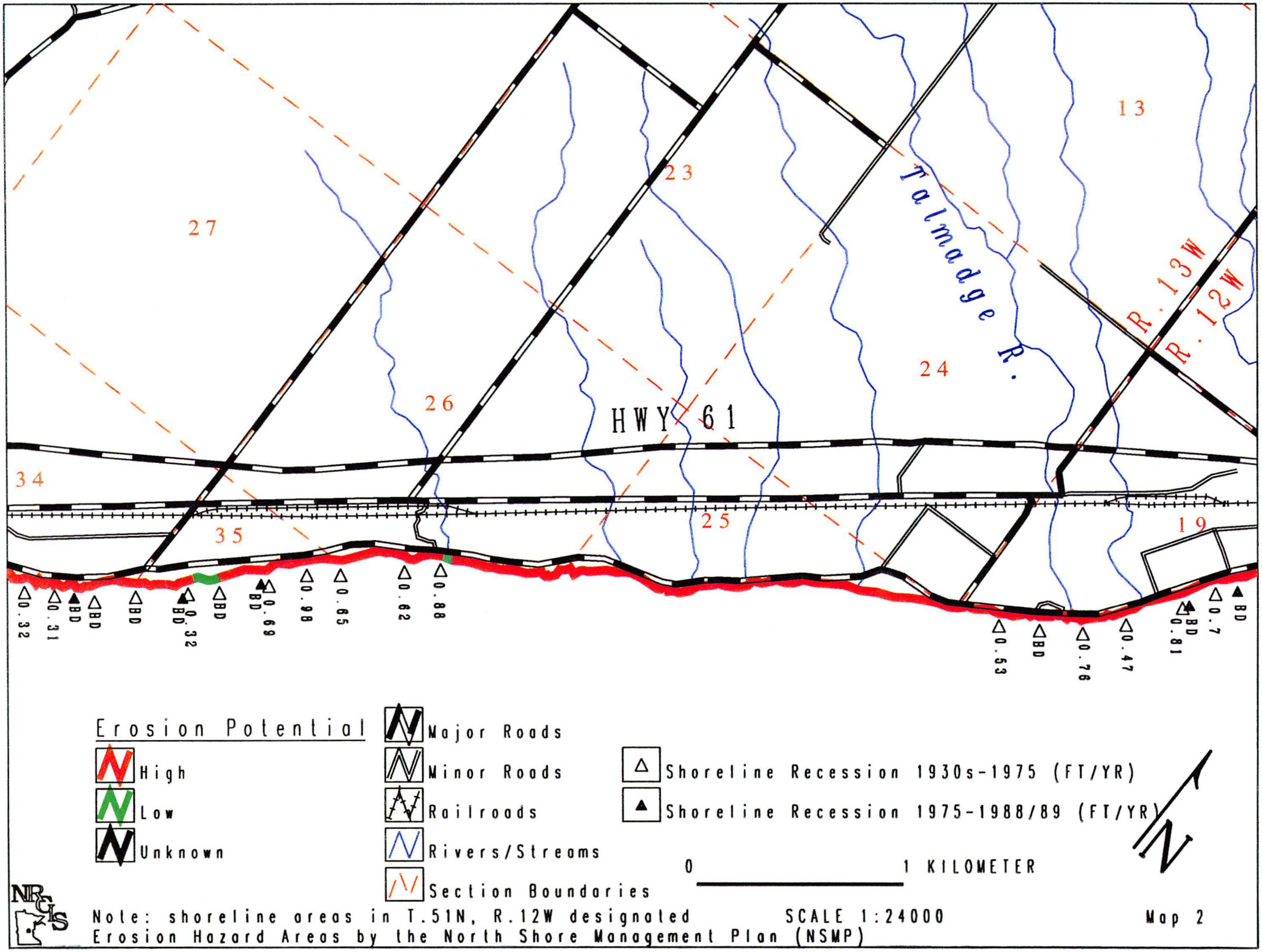
Slip Sliding Away: Erosion on Lake Superior's North Shore. Minnesota Sea Grant Extension, 1987. 4 pp.

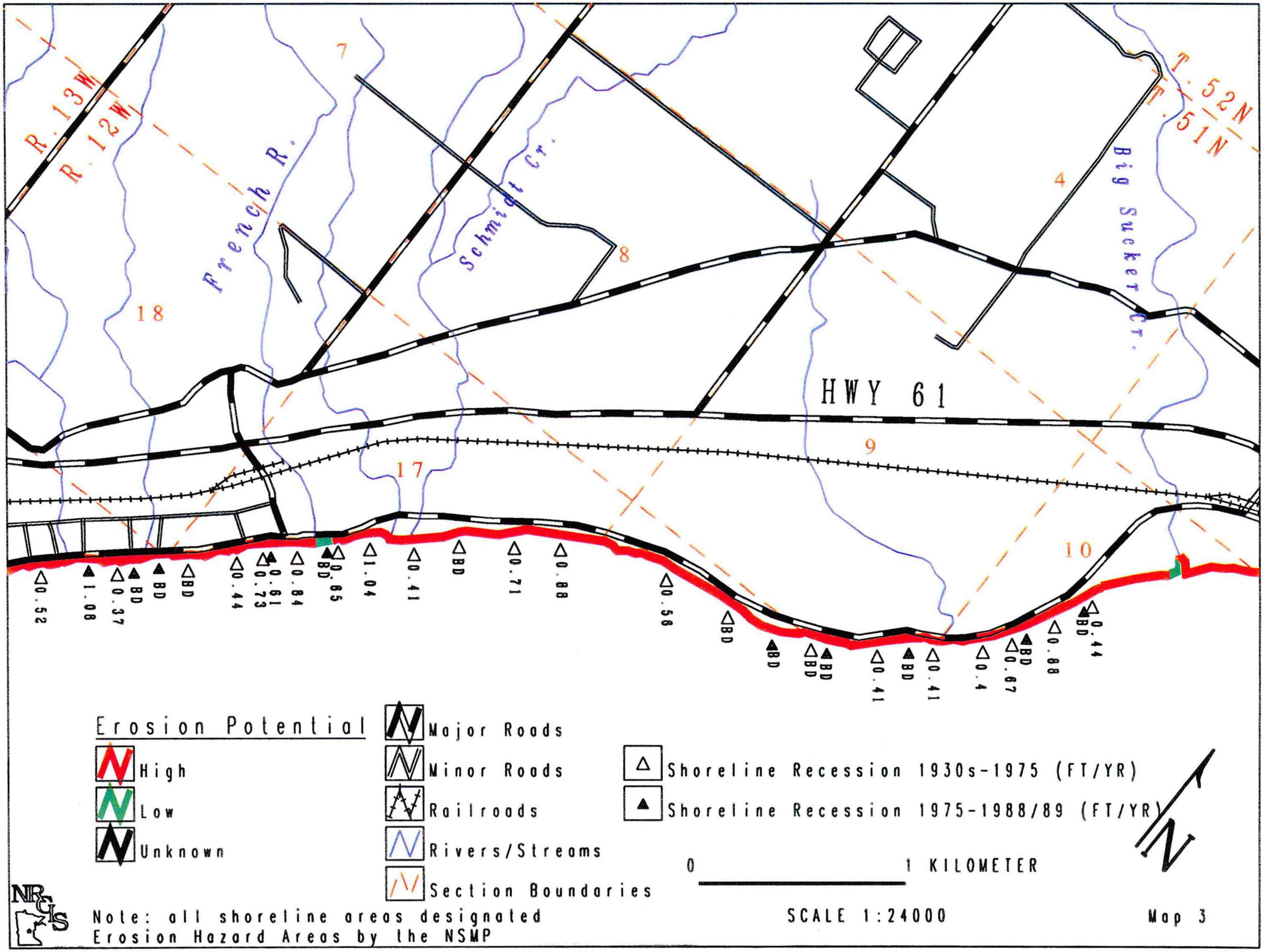
Environmental Geology of the North Shore. J. Green, M.A. Jirsa, and C.M. Moss, 1977. Minnesota Geological Survey, University of Minnesota, St. Paul. 99 pp.


Location of Shoreline Segments Covered
By Erosion Maps
Grand Portage
Grand Marais
Taconite Harbor
Silver Bay
Gooseberry Falls
Two Harbors
Knife River
Duluth
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
Note: These numbers refer to the maps on the following pages.
N
Scale = 1:940000
NRGIS

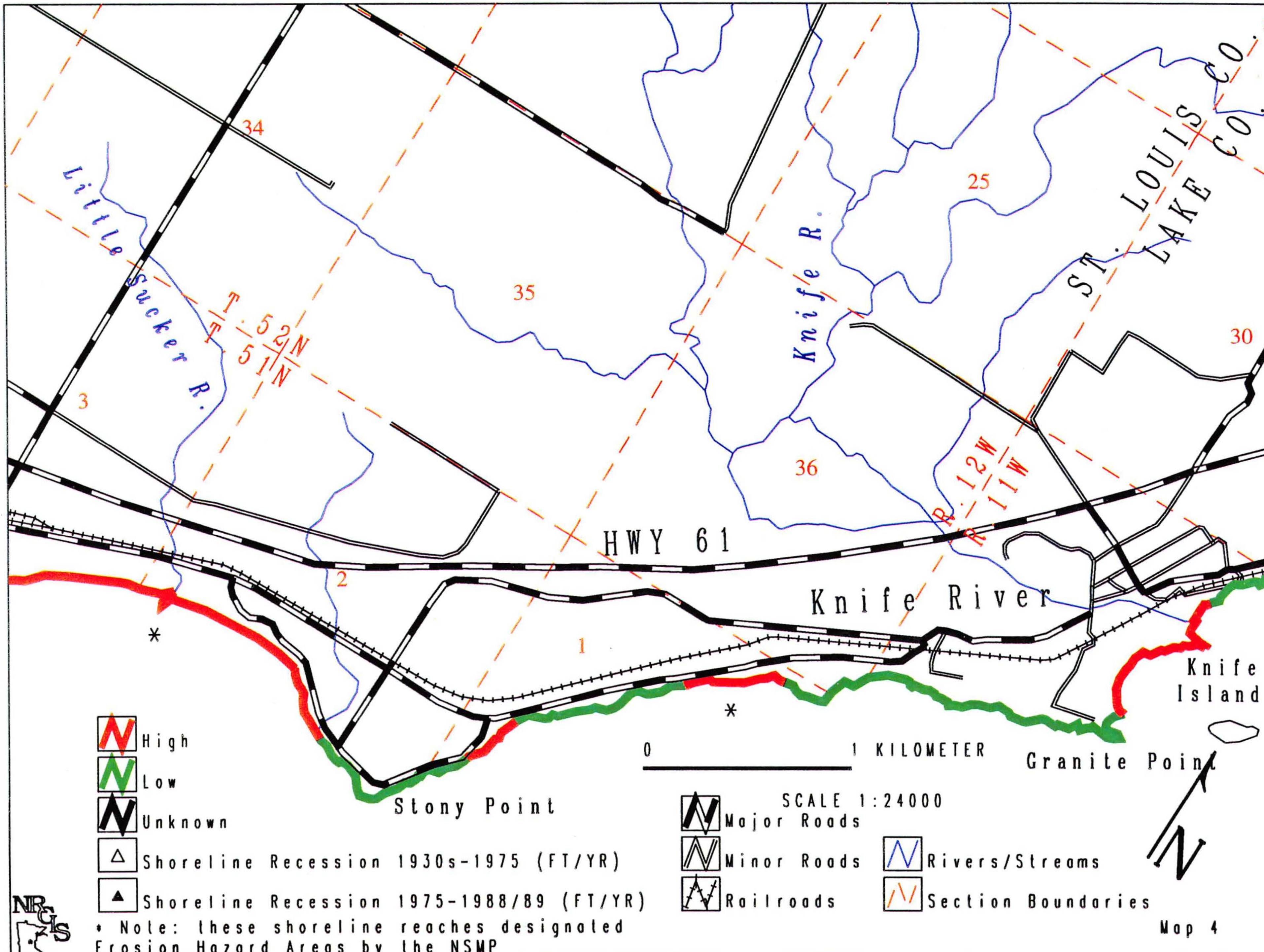


T. 51N
T. 50N
32
28
Lester R.
6
Amity Cr
33
7
8
4
HWY 61
0.44
BD
BD
BD
BD
BD
BD
0.35
0.6
BD
BD
BD
0.37
0.47
BD
0.31
BD
0.85
0.98
0.74
BD
0.3
BD
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS
Map 1

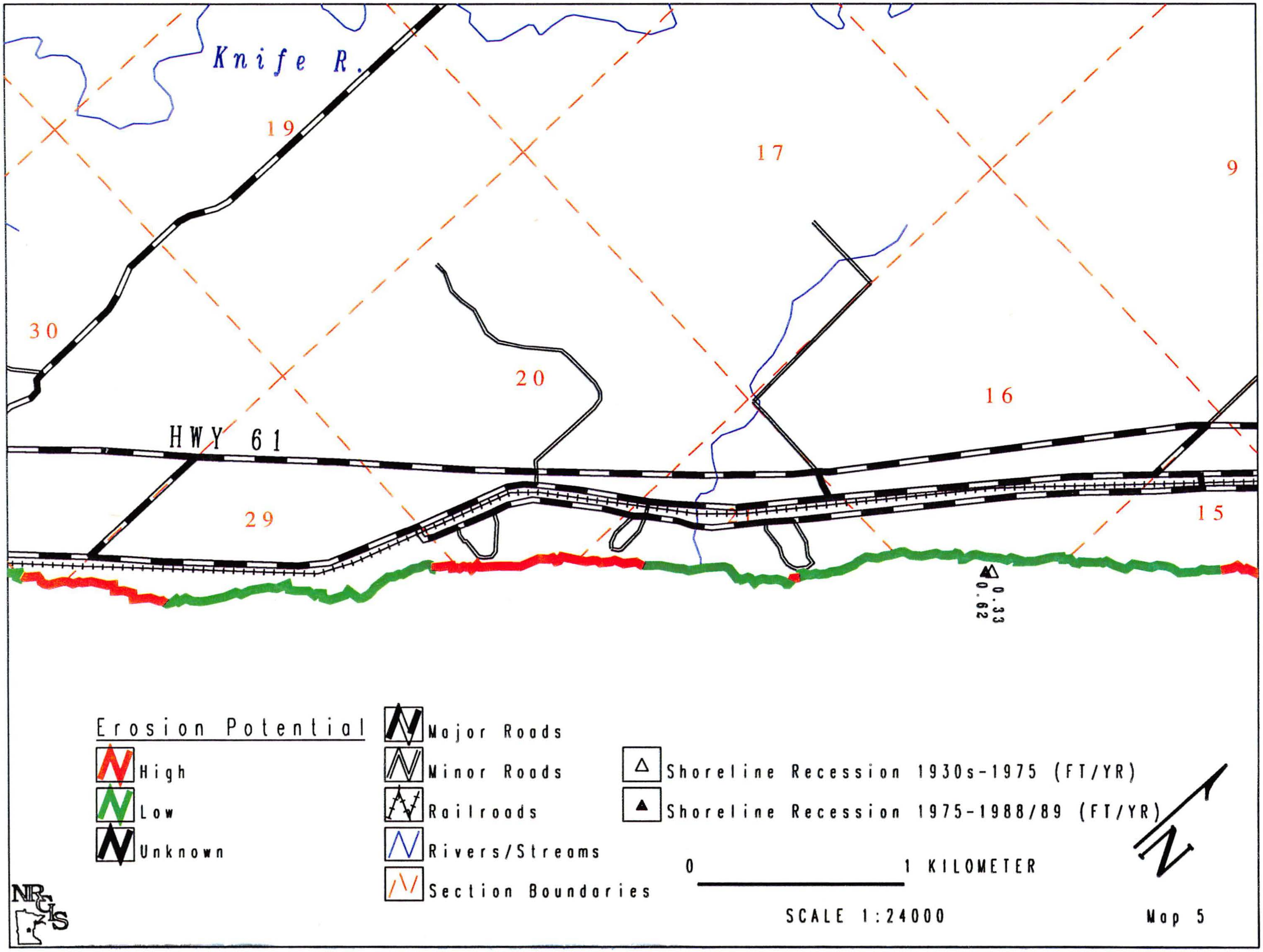

13
23
27
24
26
34
35
25
19
Talmadge R.
R. 13W
R. 12W
HWY 61
0.32
0.31
BD
BD
BD
BD
0.32
BD
BD
0.69
0.98
0.65
0.62
0.88
0.53
BD
0.76
0.47
0.81
BD
0.7
BD
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
N
NRGIS
Note: shoreline areas in T.51N, R.12W designated
Erosion Hazard Areas by the North Shore Management Plan (NSMP)
SCALE 1:24000
Map 2

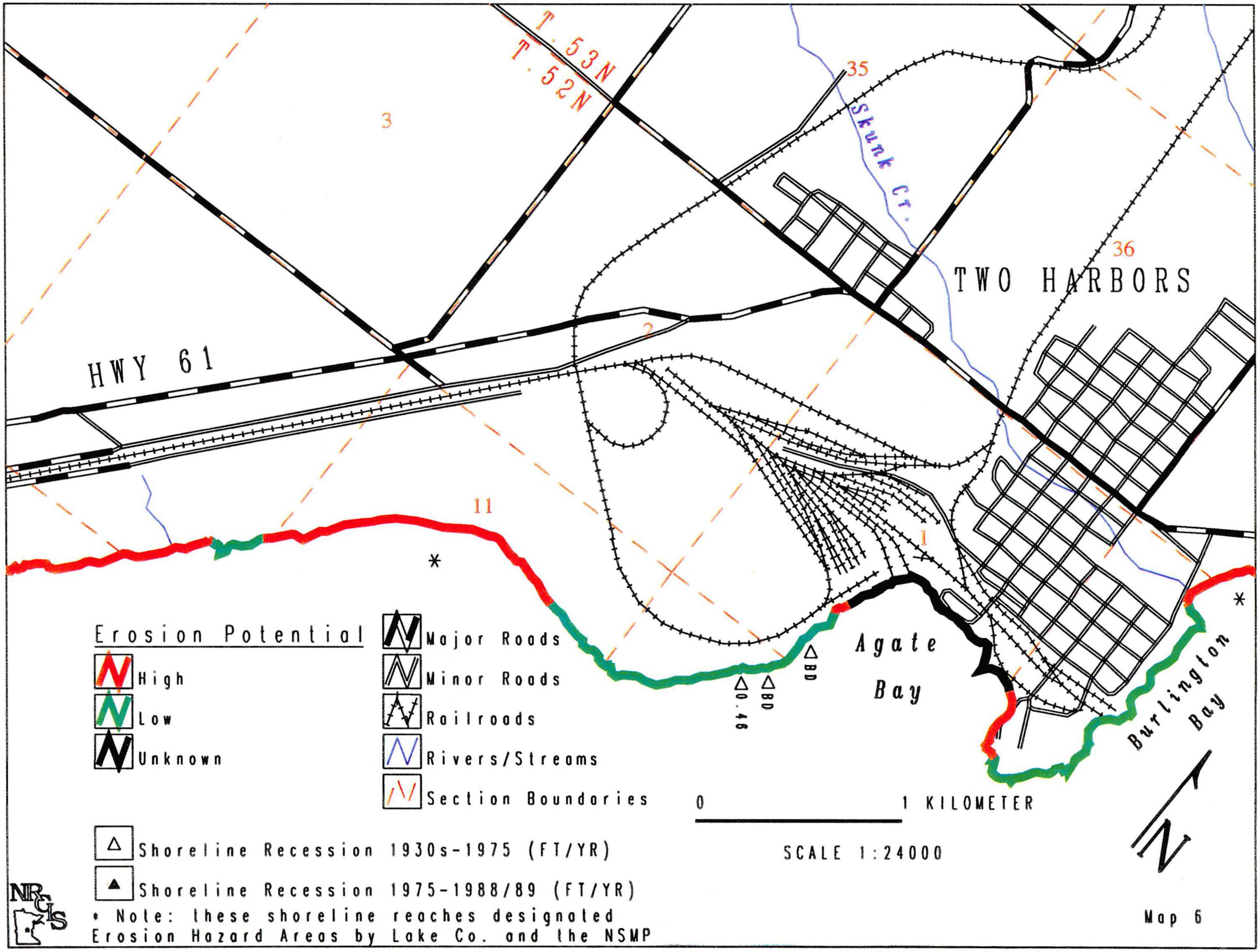


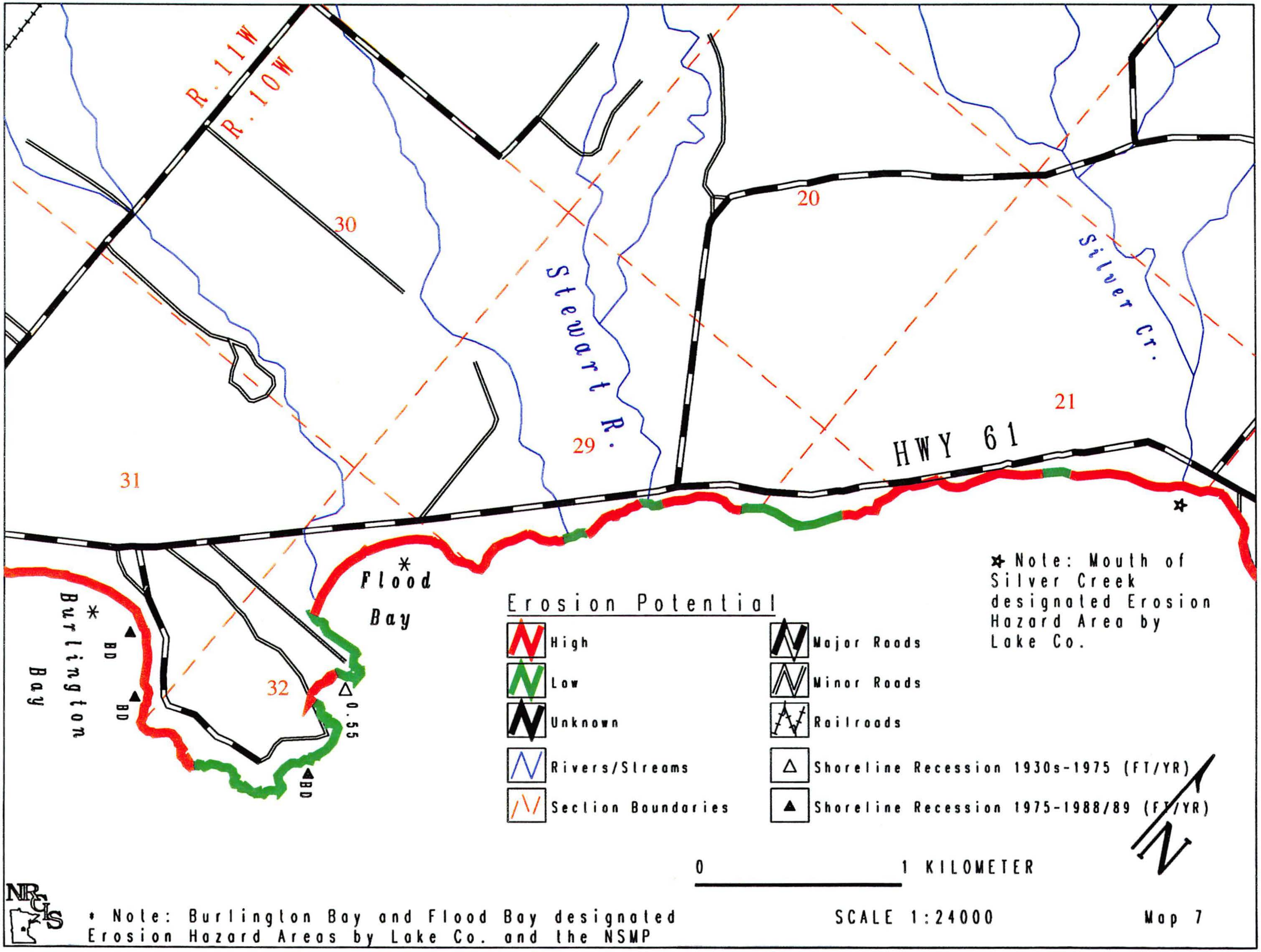
R.13W
R.12W
T.52N
T.51N
French R.
Schmidt Cr.
Big Sucker Cr.
HWY 61
7
8
18
4
9
17
10
0.52
1.08
0.37
BD
BD
BD
0.44
0.73
0.61
0.84
BD
0.65
1.04
0.41
BD
0.71
0.88
0.56
BD
BD
BD
BD
0.41
BD
0.41
0.4
0.67
BD
0.88
BD
0.44
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
N
NRGIS
Note: all shoreline areas designated
Erosion Hazard Areas by the NSMP
SCALE 1:24000
Map 3

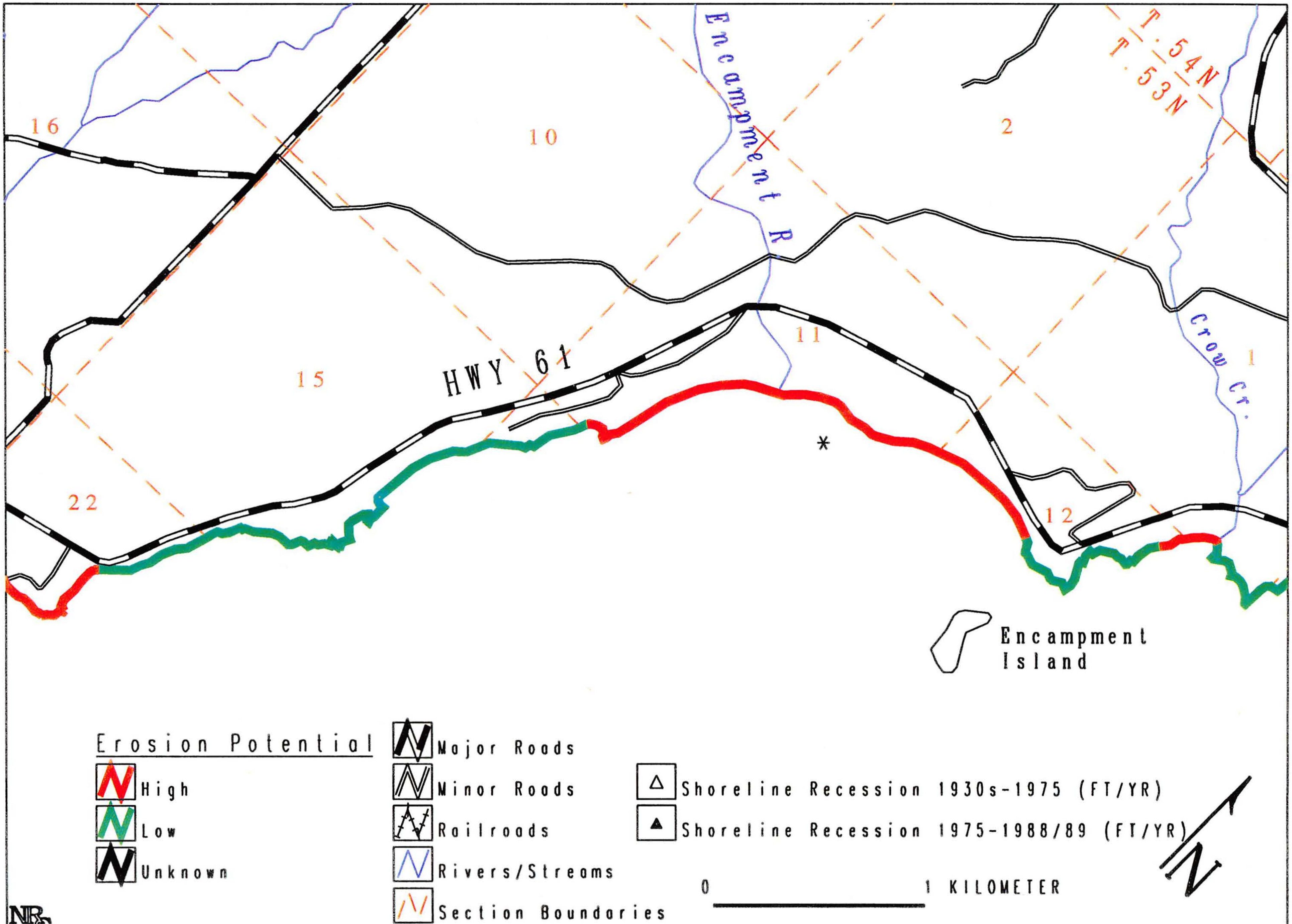


34
Little Sucker R.
T. 52 N
T. 51 N
35
Knife R.
25
ST. LOUIS CO.
LAKE CO.
30
3
36
R. 12 W
R. 11 W
HWY 61
2
Knife River
1
Knife Island
Granite Point
Stony Point
0
1 KILOMETER
SCALE 1:24000
High
Low
Unknown
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
* Note: these shoreline reaches designated
Erosion Hazard Areas by the NSMP
Map 4


Knife R.
19
17
9
30
20
16
HWY 61
29
15
0.33
0.62
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS
Map 5


T.53N
T.52N
3
35
Skunk Cr.
36
TWO HARBORS
2
HWY 61
11
*
1
Agate Bay
Burlington Bay
*
0.46
BD
BD
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
0
1 KILOMETER
SCALE 1:24000
N
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
* Note: these shoreline reaches designated Erosion Hazard Areas by Lake Co. and the NSMP
Map 6

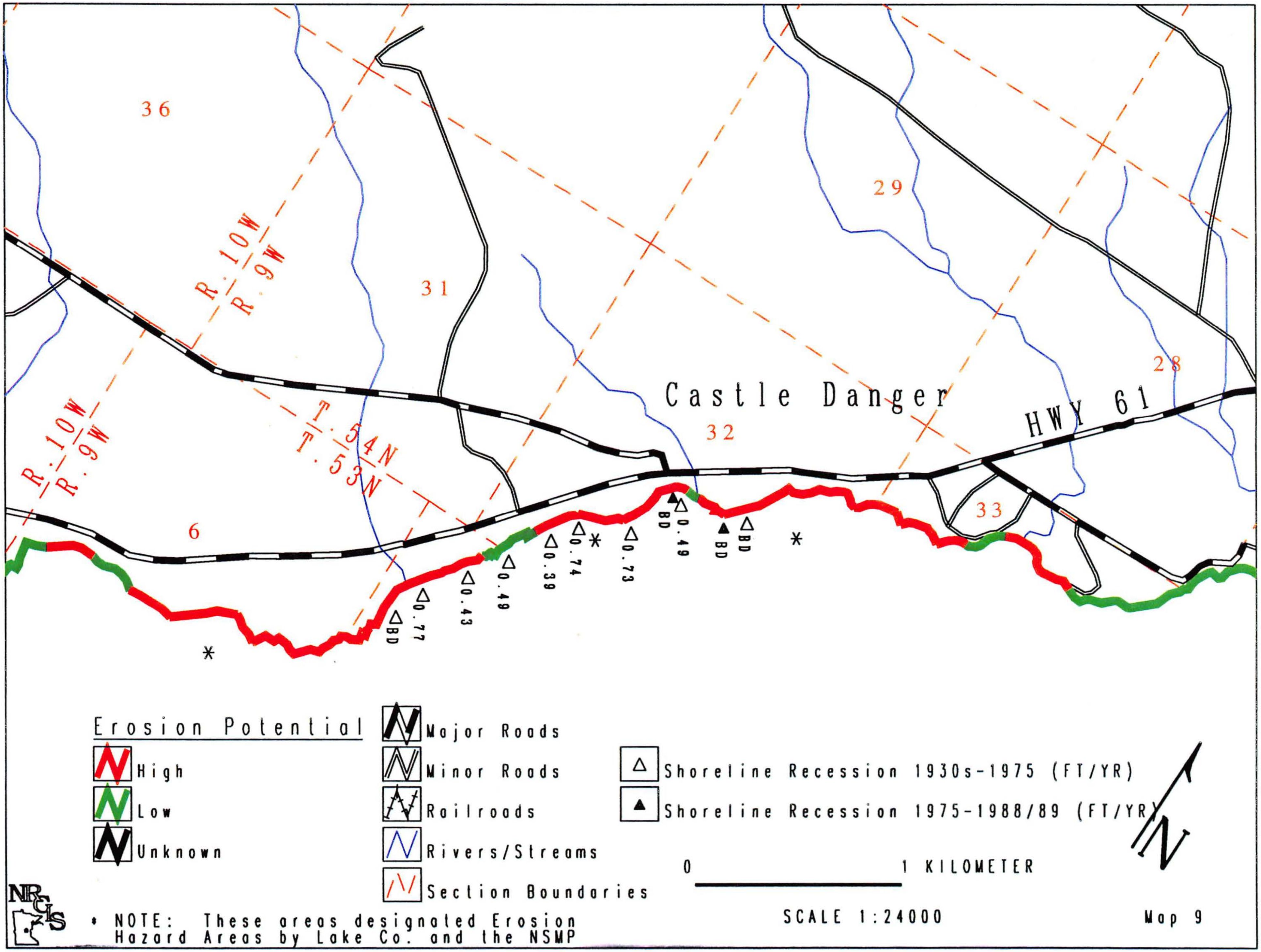

R. 11W
R. 10W
30
20
21
29
31
32
Stewart R.
Silver Cr.
HWY 61
Flood Bay
Burlington Bay
BD
0.55
Erosion Potential
High
Low
Unknown
Rivers/Streams
Section Boundaries
Major Roads
Minor Roads
Railroads
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
Note: Mouth of Silver Creek designated Erosion Hazard Area by Lake Co.
0
1 KILOMETER
SCALE 1:24000
Map 7
NRGIS
* Note: Burlington Bay and Flood Bay designated Erosion Hazard Areas by Lake Co. and the NSMP



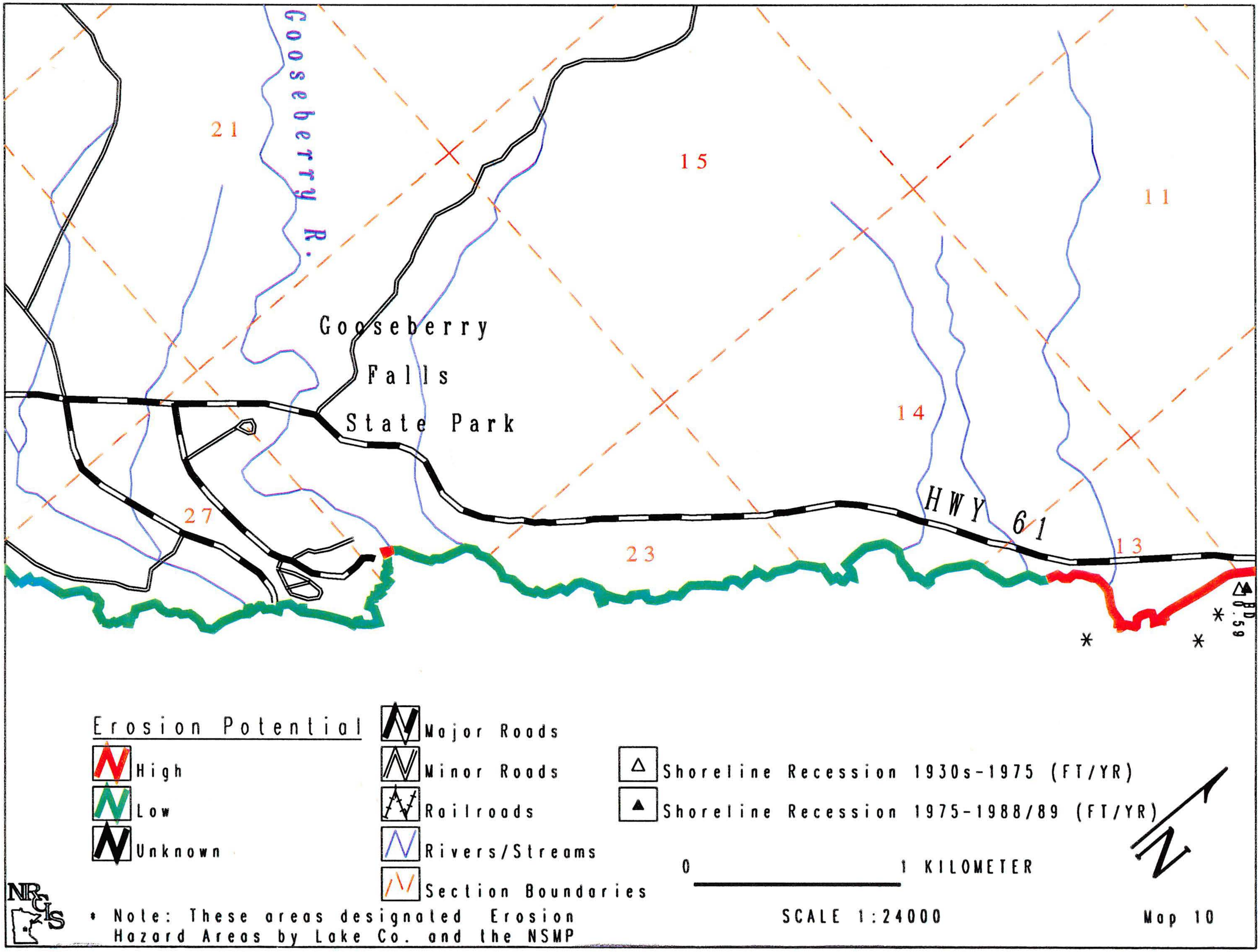
* Note: This shoreline reach designated an Erosion Hazard Area by Lake Co. and the NSMP

SCALE 1:24000

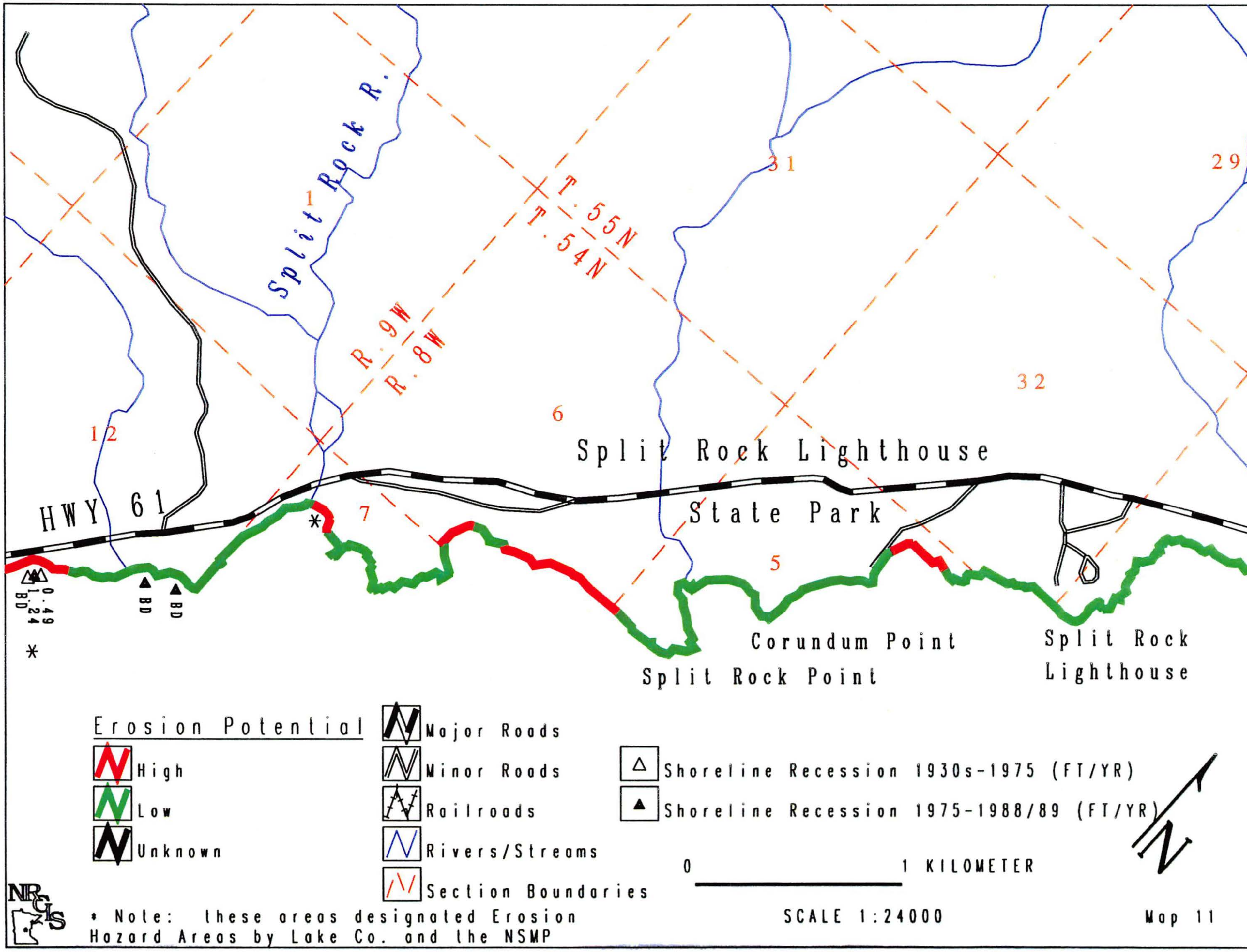
Map 8

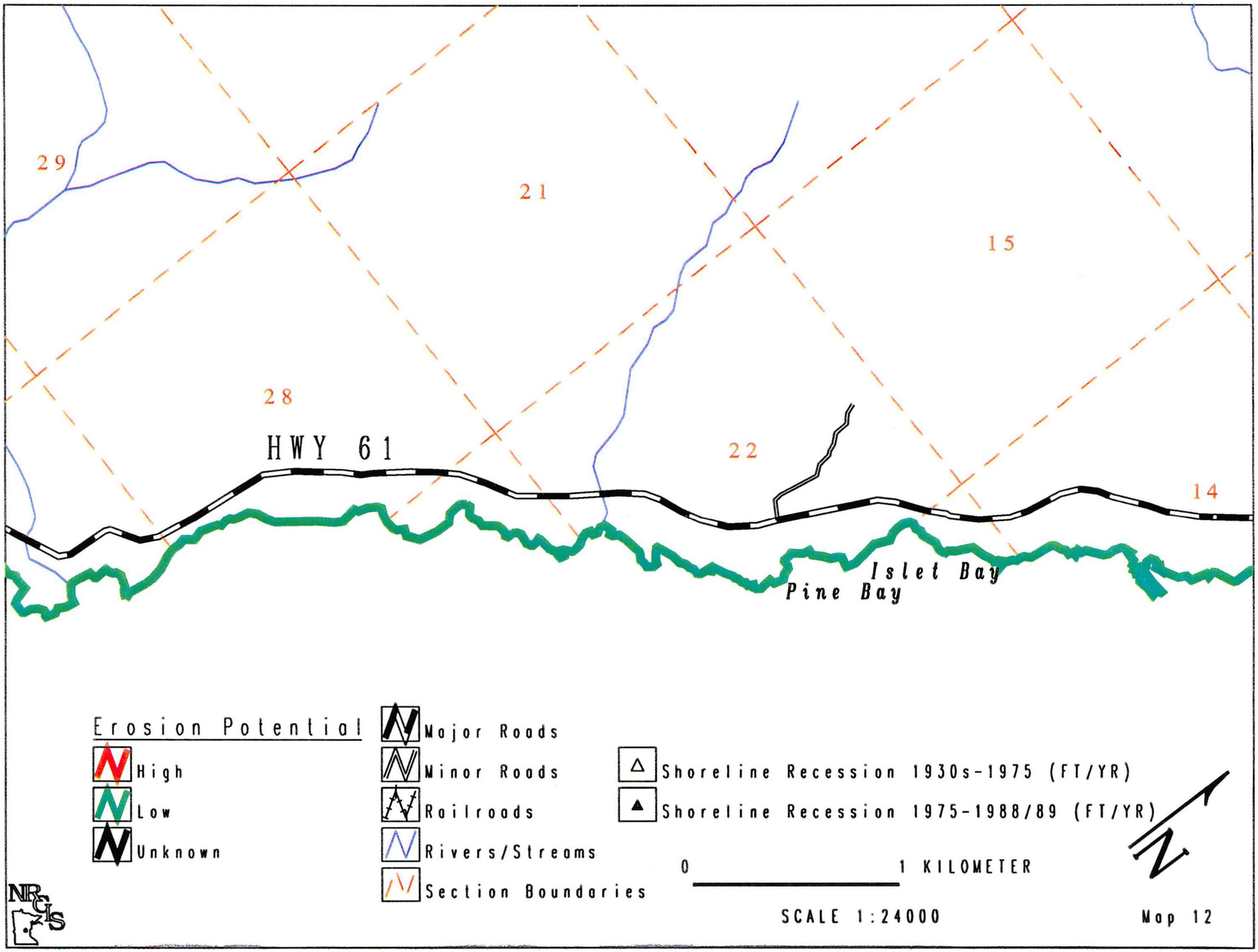


36
31
29
28
32
33
6
R. 10W
R. 9W
R. 10W
R. 9W
T. 54N
T. 53N
Castle Danger
HWY 61
BD
0.77
0.43
0.49
0.39
0.74
0.73
BD
0.49
BD
BD
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
Map 9
NRGIS
* NOTE: These areas designated Erosion Hazard Areas by Lake Co. and the NSMP

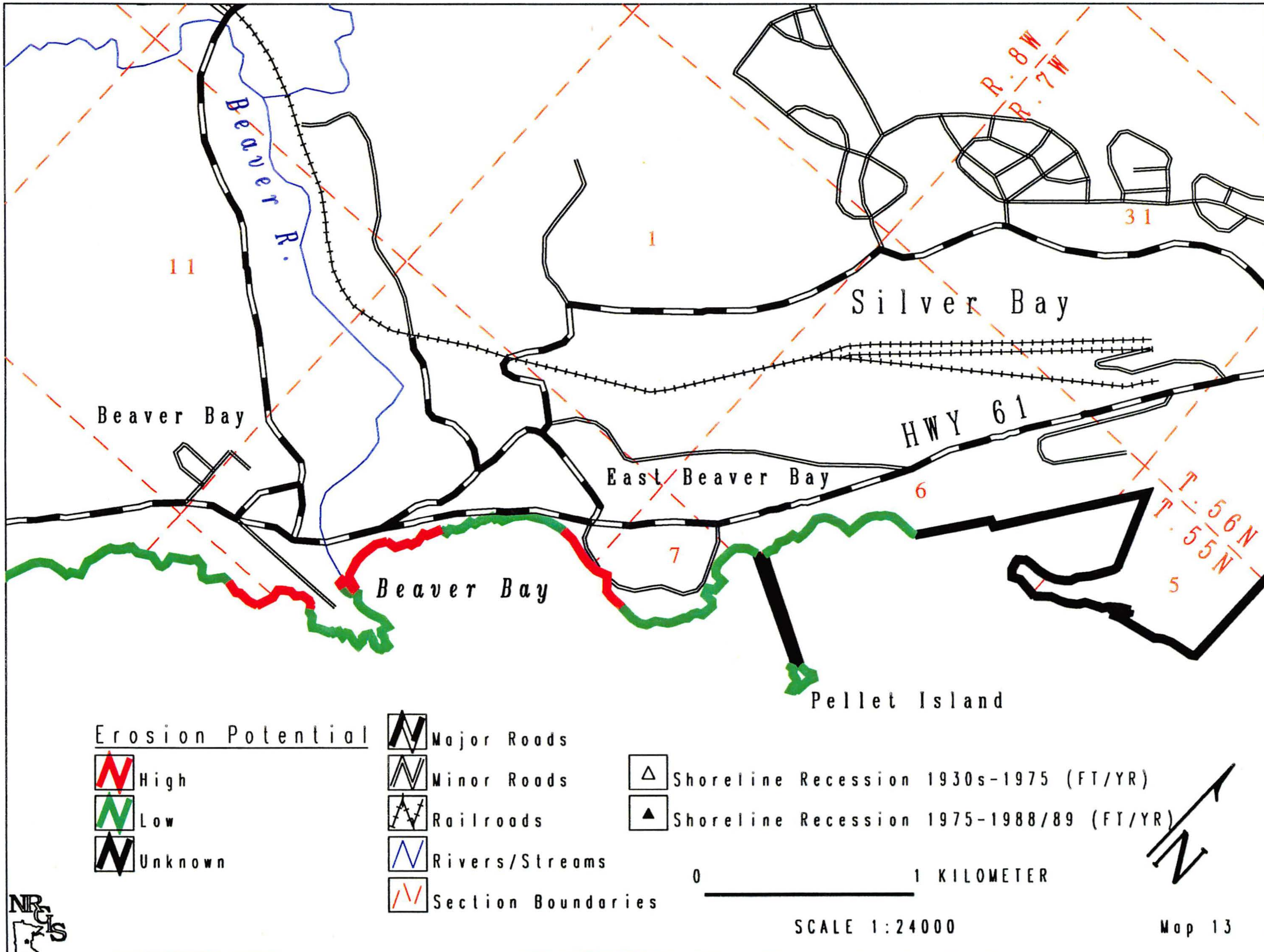


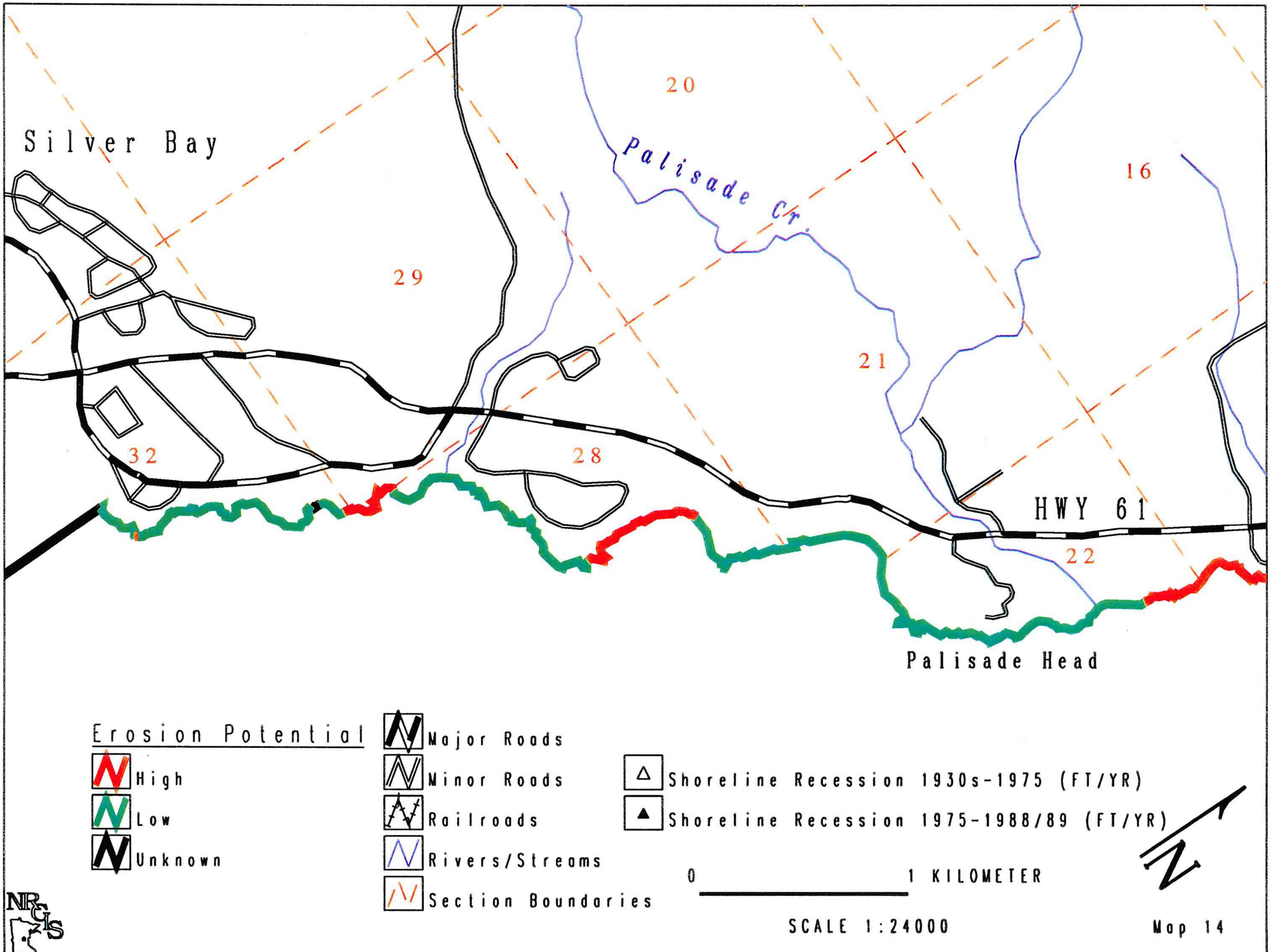
Gooseberry R.
21
15
11
14
27
23
13
Gooseberry
Falls
State Park
HWY 61
BD
0.59
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS
* Note: These areas designated Erosion Hazard Areas by Lake Co. and the NSMP
Map 10


Split Rock R.
T.55N
T.54N
R.9W
R.8W
1
31
29
12
6
32
7
5
HWY 61
Split Rock Lighthouse
State Park
Corundum Point
Split Rock Point
Split Rock
Lighthouse
BD
0.49
1.24
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
Map 11
NRGIS
* Note: these areas designated Erosion
Hazard Areas by Lake Co. and the NSMP



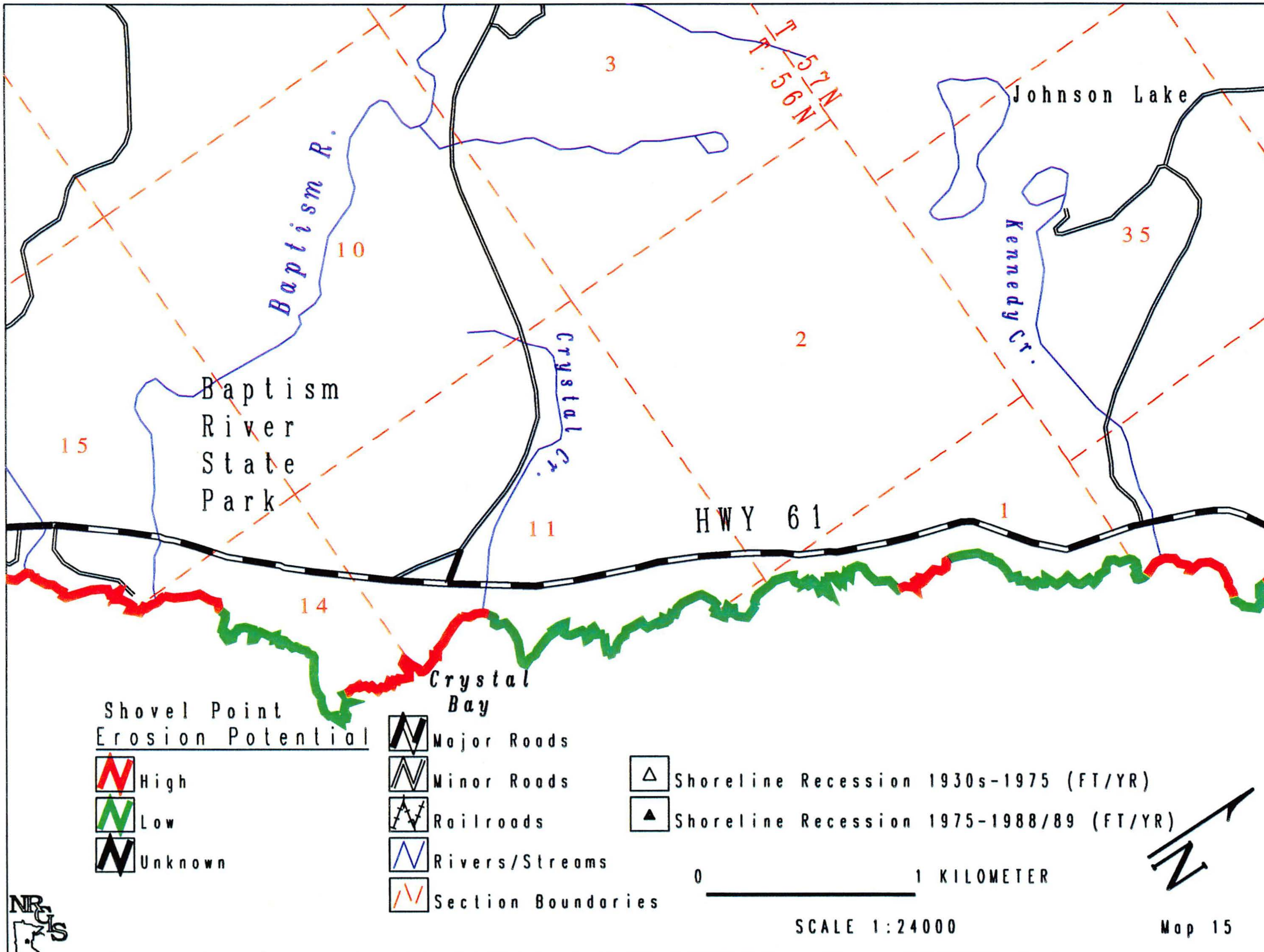
29
21
15
28
22
14
HWY 61
Islet Bay
Pine Bay
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS
Map 12


Beaver R.
11
1
31
R. 8W
R. 7W
Silver Bay
Beaver Bay
HWY 61
East Beaver Bay
6
T. 56N
T. 55N
7
5
Beaver Bay
Pellet Island
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
N
0
1 KILOMETER
SCALE 1:24000
Map 13
NRGIS

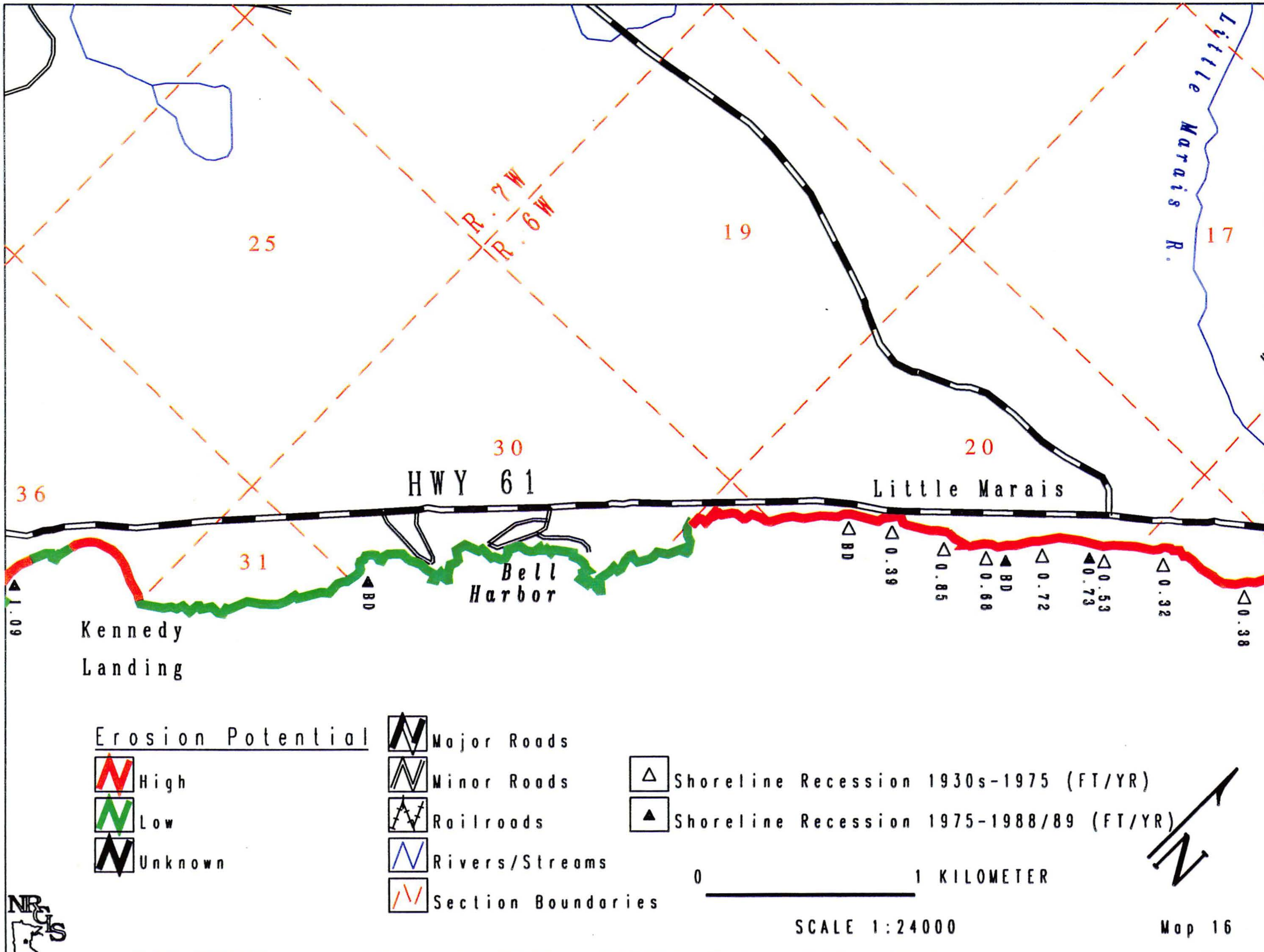


Silver Bay
20
Palisade Cr.
16
29
21
32
28
HWY 61
22
Palisade Head
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS

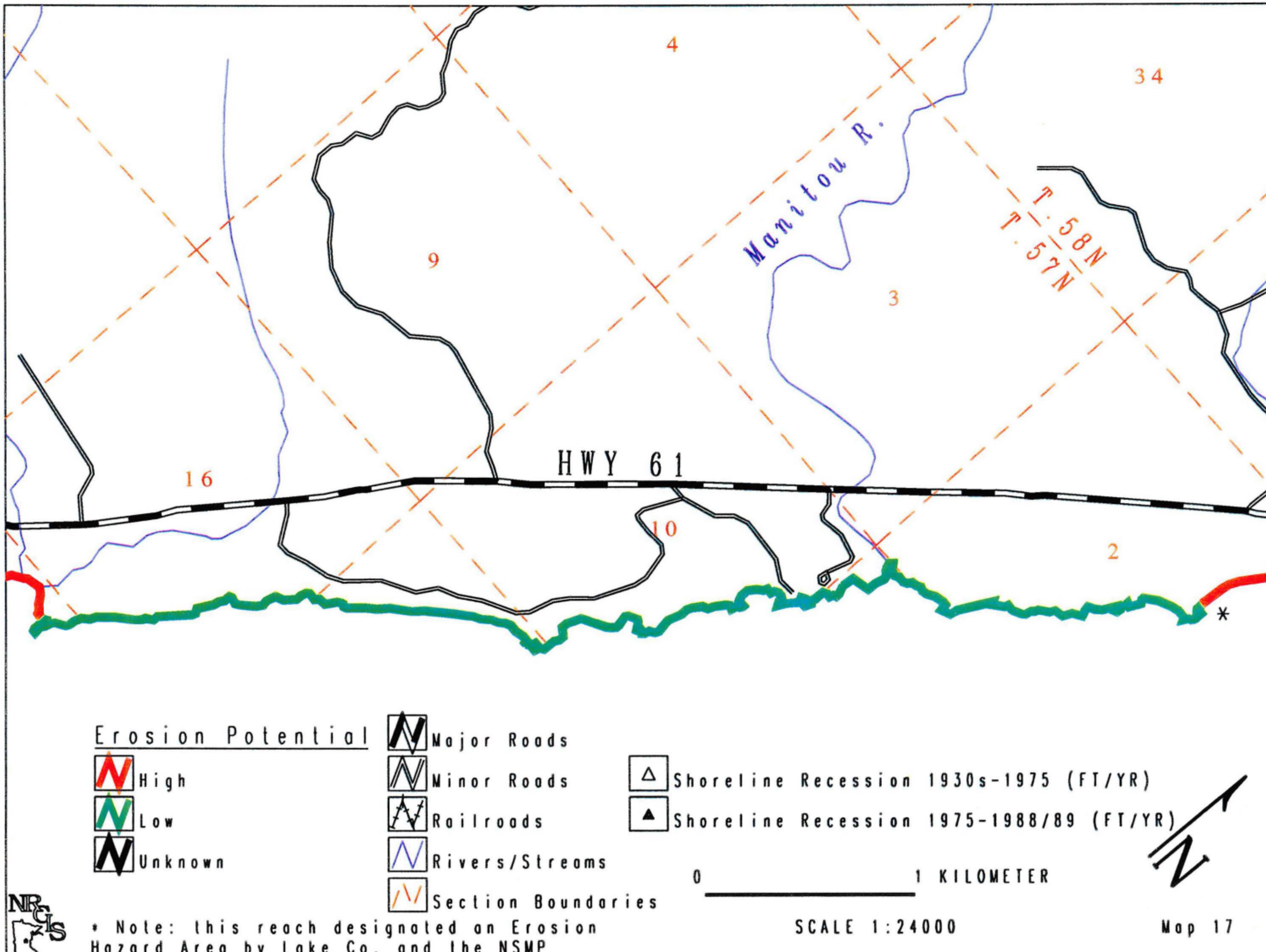
Map 14



3
T 57N
T 56N
Johnson Lake
Baptism R.
10
35
Kennedy Cr.
2
Crystal Cr.
Baptism
River
State
Park
15
HWY 61
1
11
14
Crystal
Bay
Shovel Point
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
Map 15
NRGIS
N



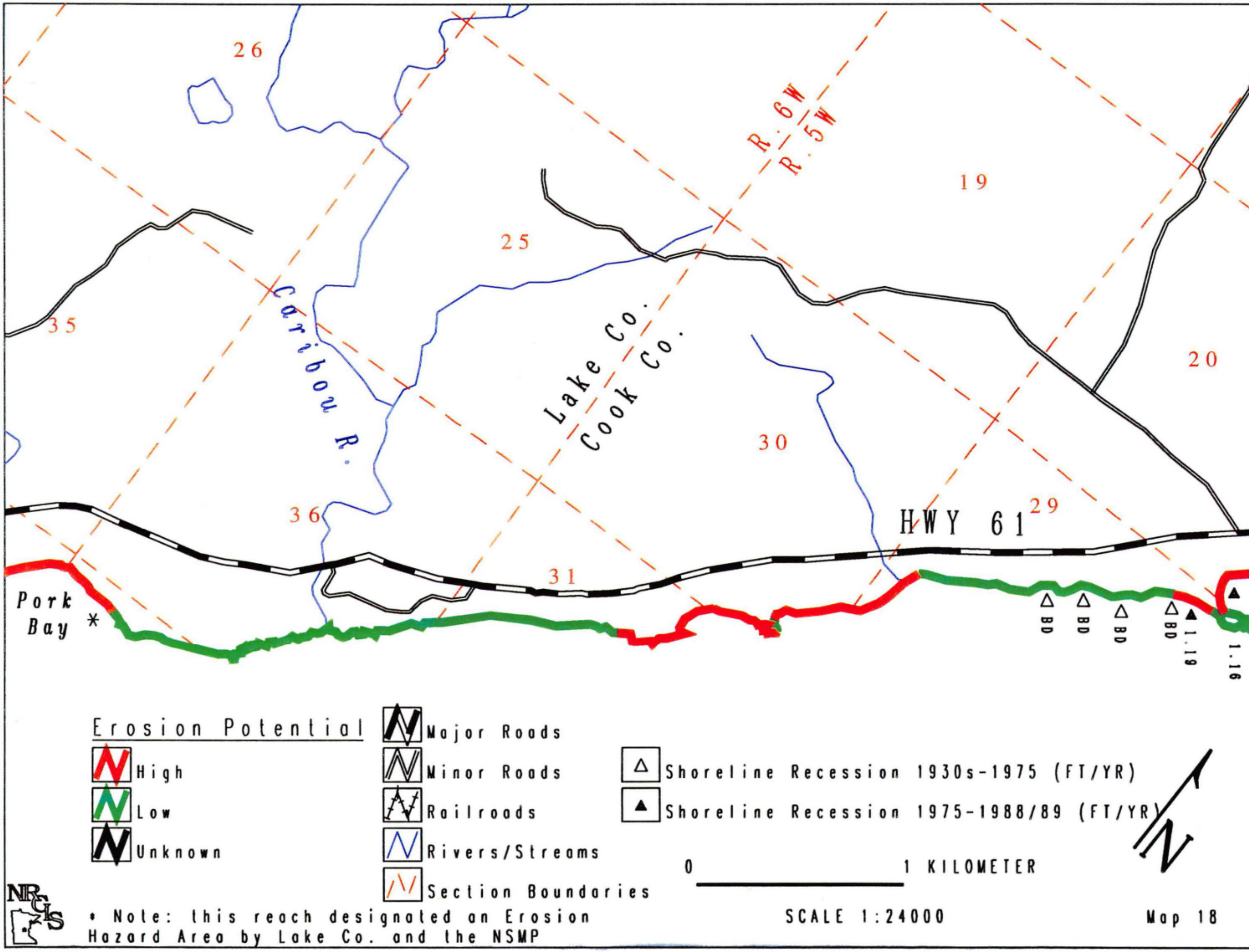
25
19
17
R. 7W
R. 6W
Little Marais R.
36
30
20
31
HWY 61
Little Marais
Bell Harbor
Kennedy Landing
1.09
BD
BD
0.39
0.85
0.68
BD
0.72
0.73
0.53
0.32
0.38
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
Map 16
NRGIS



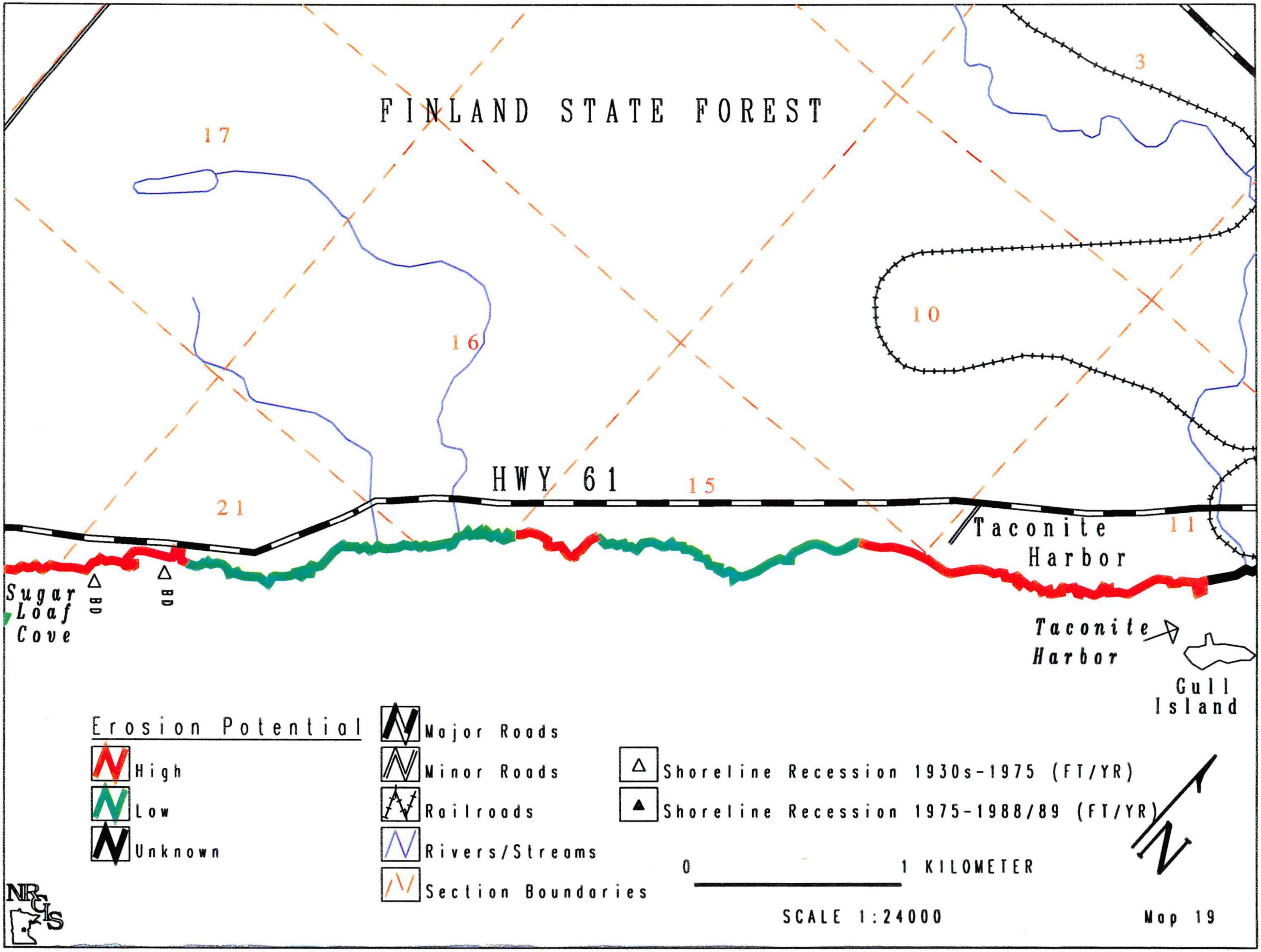
* Note: this reach designated an Erosion Hazard Area by Lake Co. and the NSMP

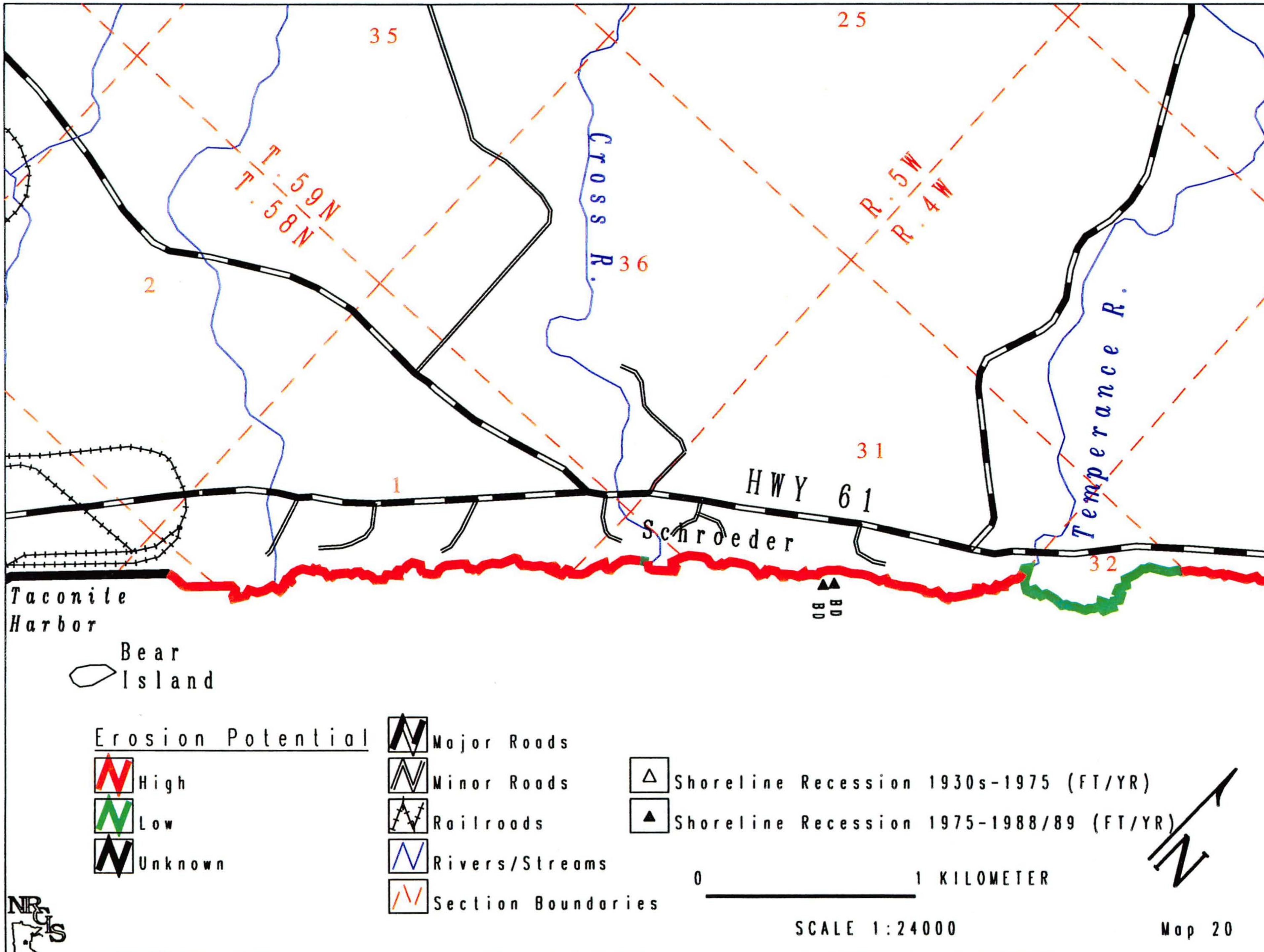
SCALE 1:24000

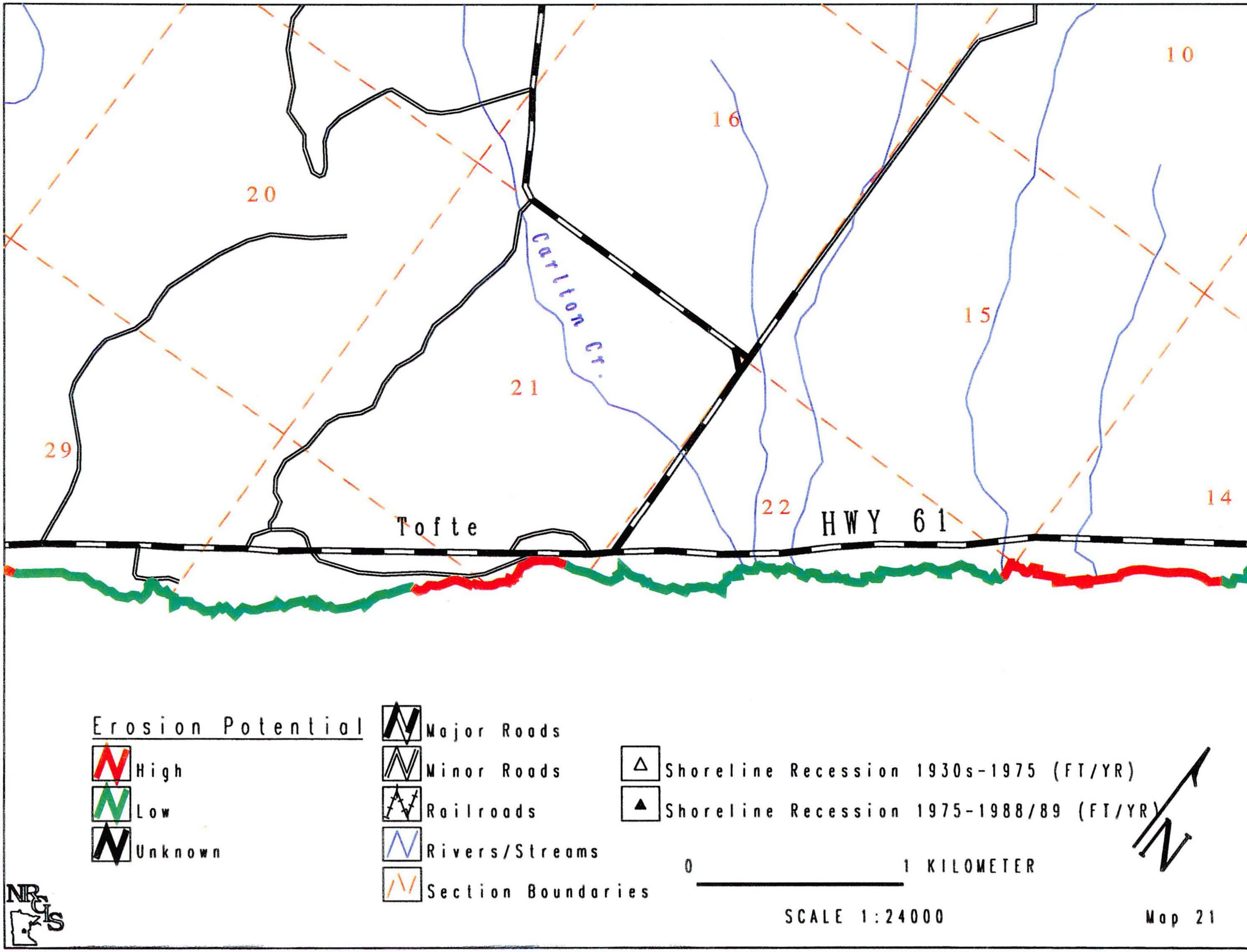
Map 17



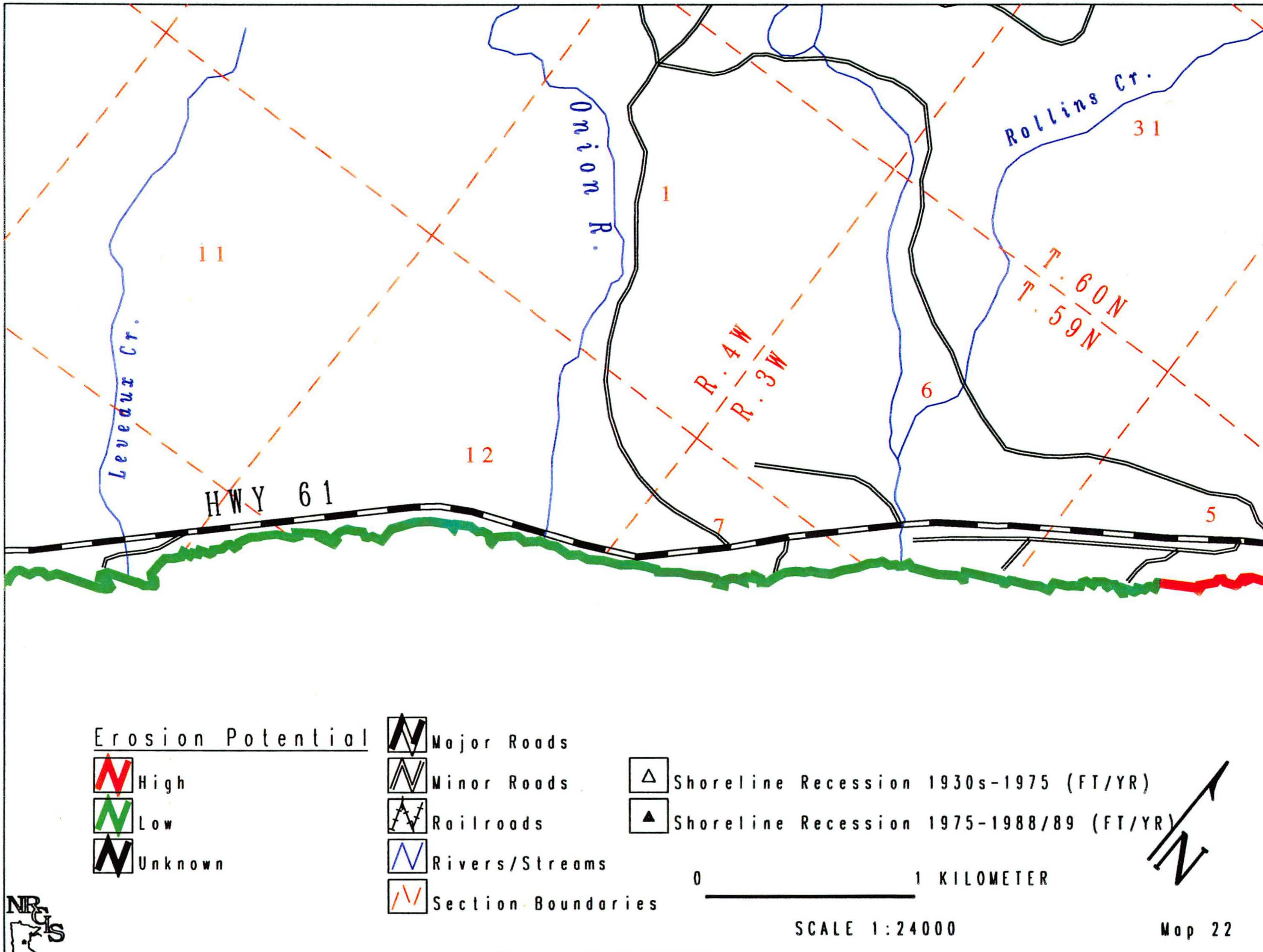
26
25
35
36
31
30
19
20
29
R. 6W
R. 5W
Caribou R.
Lake Co.
Cook Co.
HWY 61
Pork Bay *
BD
BD
BD
BD
1.19
1.16
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
N
NRGIS
* Note: this reach designated an Erosion Hazard Area by Lake Co. and the NSMP
SCALE 1:24000
Map 18


FINLAND STATE FOREST
17
3
16
10
HWY 61
15
21
11
Taconite Harbor
Sugar Loaf Cove
BD
BD
Taconite Harbor
Gull Island
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
N
0
1 KILOMETER
SCALE 1:24000
Map 19
NRGIS

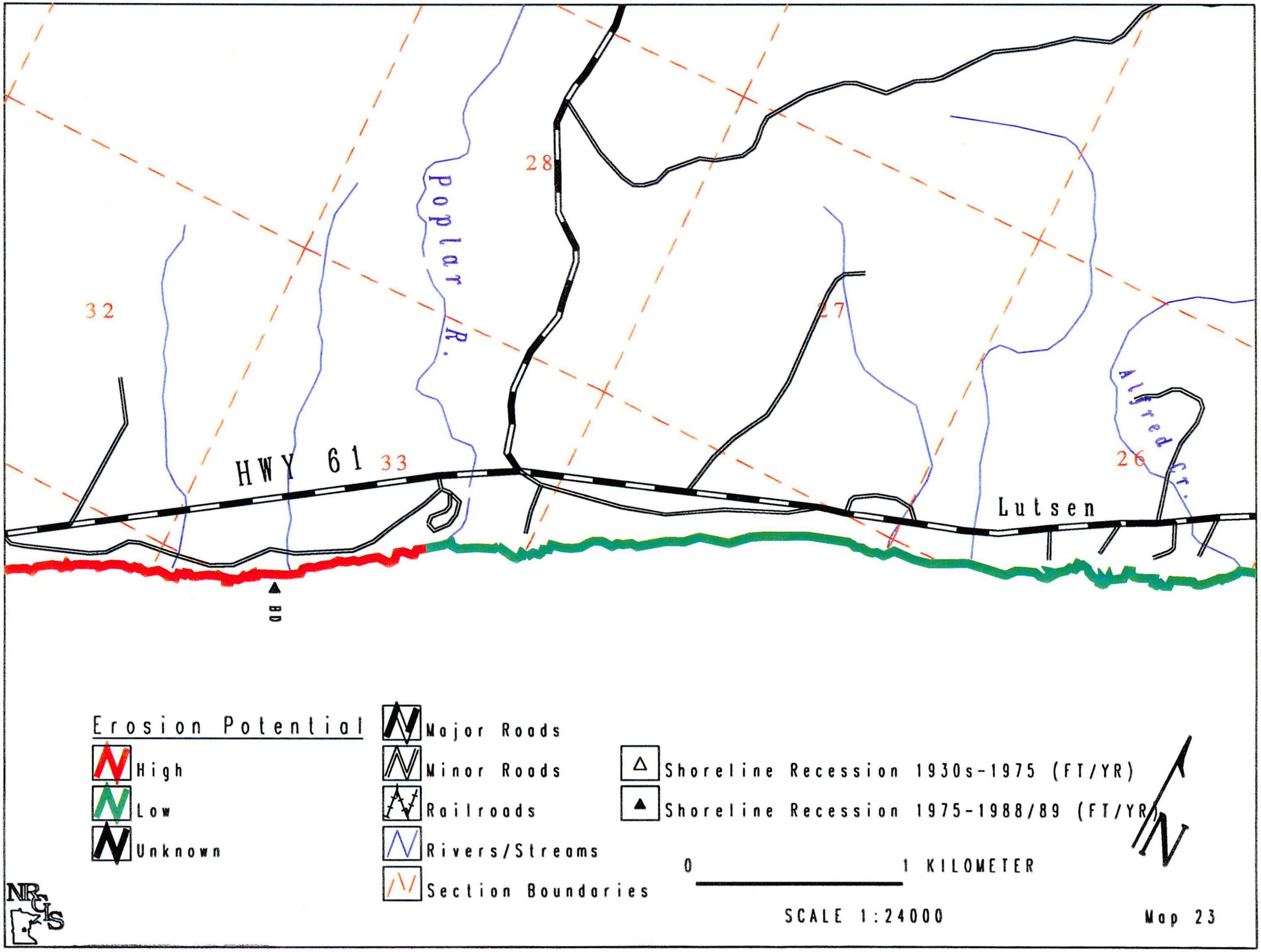

35
25
T. 59N
T. 58N
R. 5W
R. 4W
Cross R.
36
2
31
1
HWY 61
Schroeder
Temperance R.
32
Taconite Harbor
BD
BD
Bear Island
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
Map 20

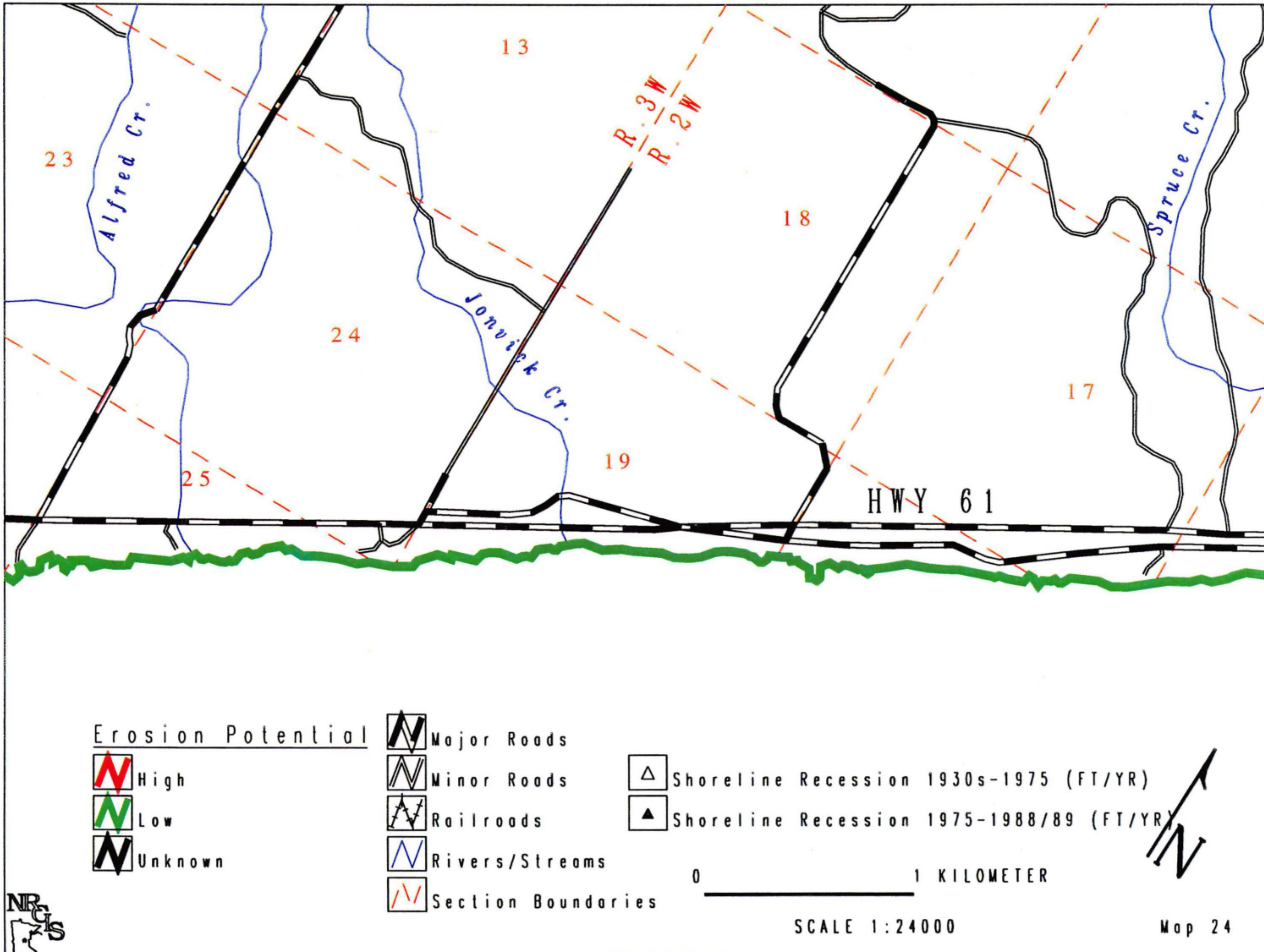


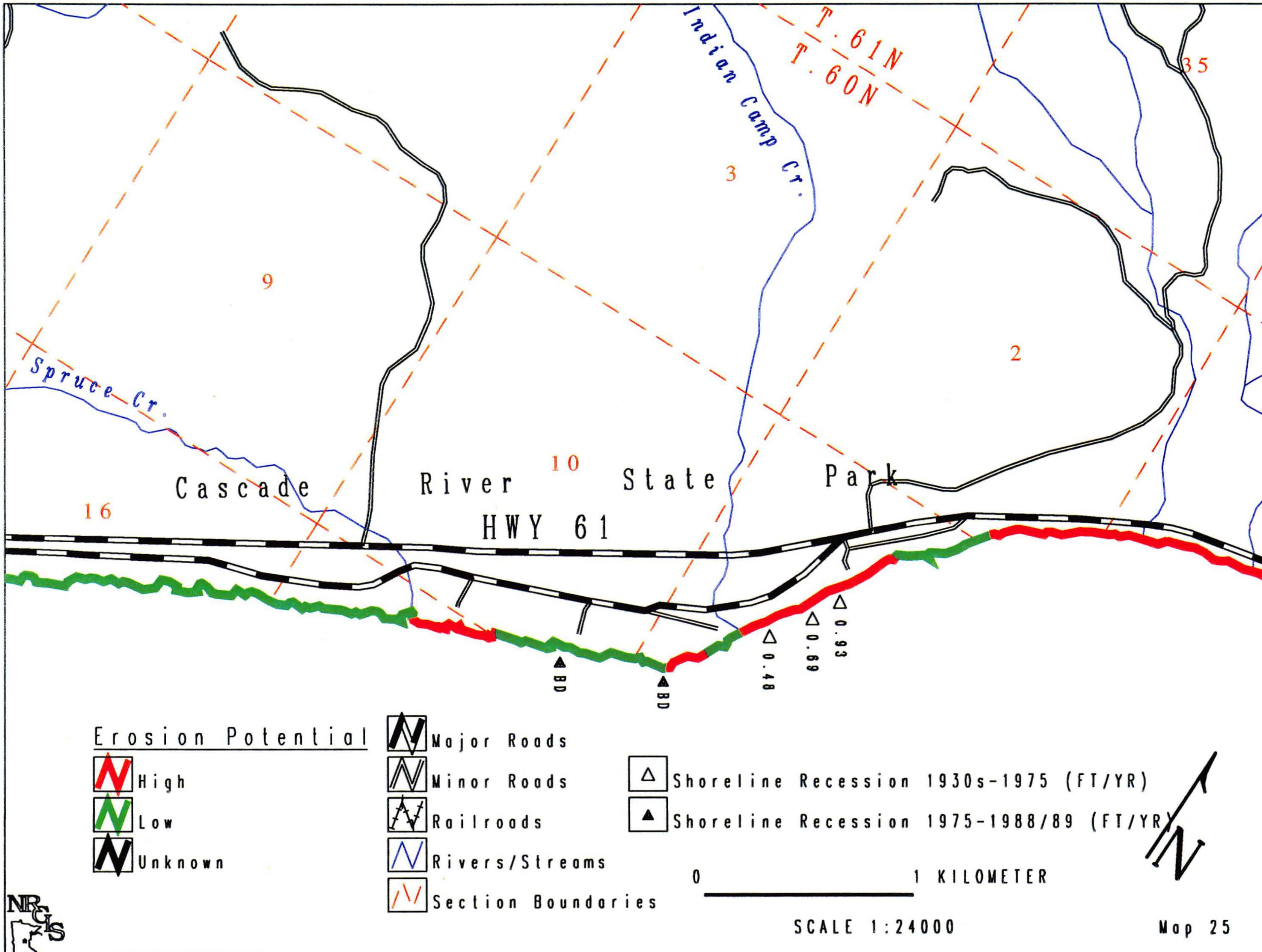
10
16
20
15
21
29
22
14
Carlton Cr.
Tofte
HWY 61
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
N
NRGIS
SCALE 1:24000
Map 21



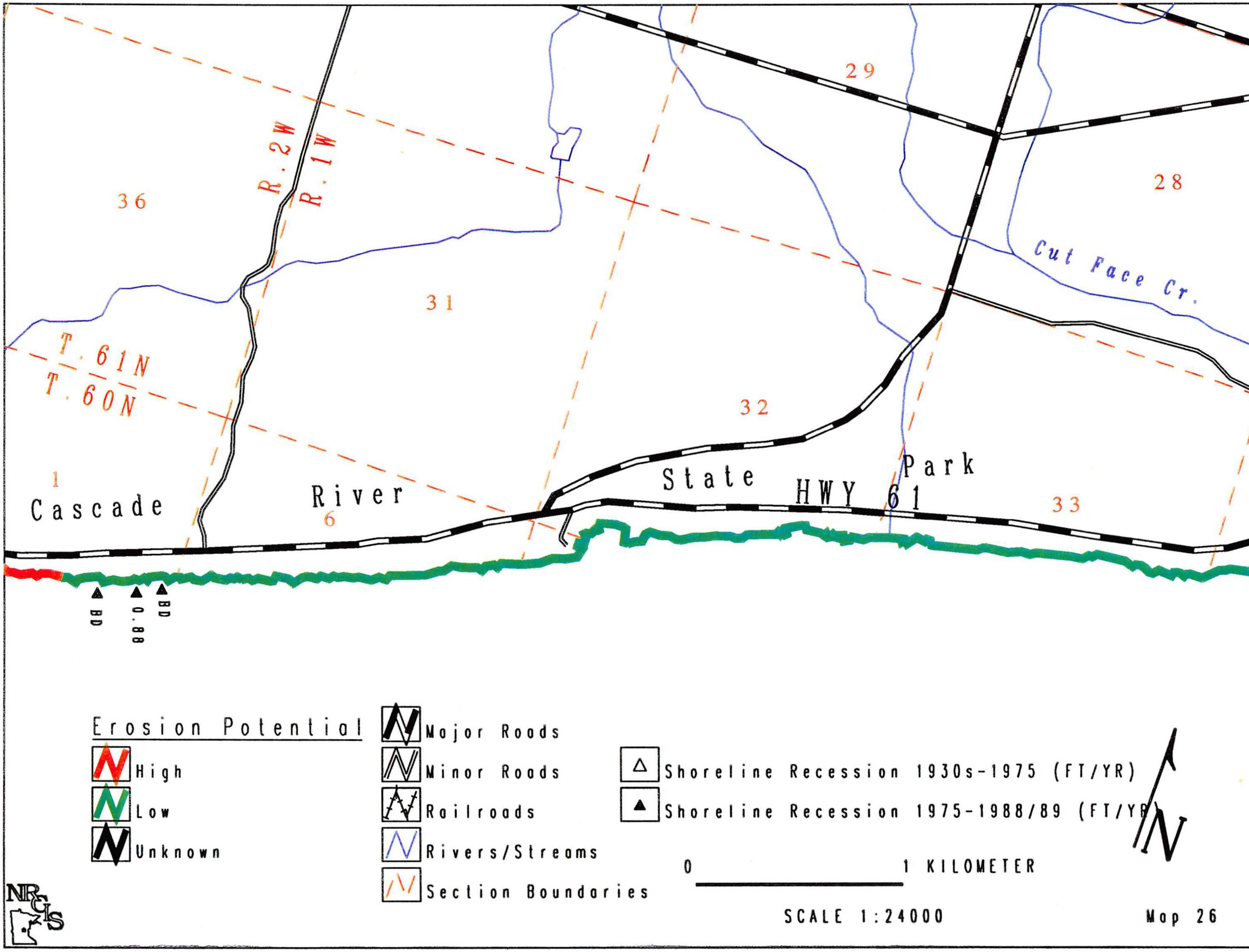
Onion R.
Rollins Cr.
Leveaux Cr.
HWY 61
1
11
12
6
7
5
31
T.60N
T.59N
R.4W
R.3W
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS
Map 22


HWY 61
Lutsen
Poplar R.
Alfred Cr.
32
33
28
27
26
BD
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS
Map 23

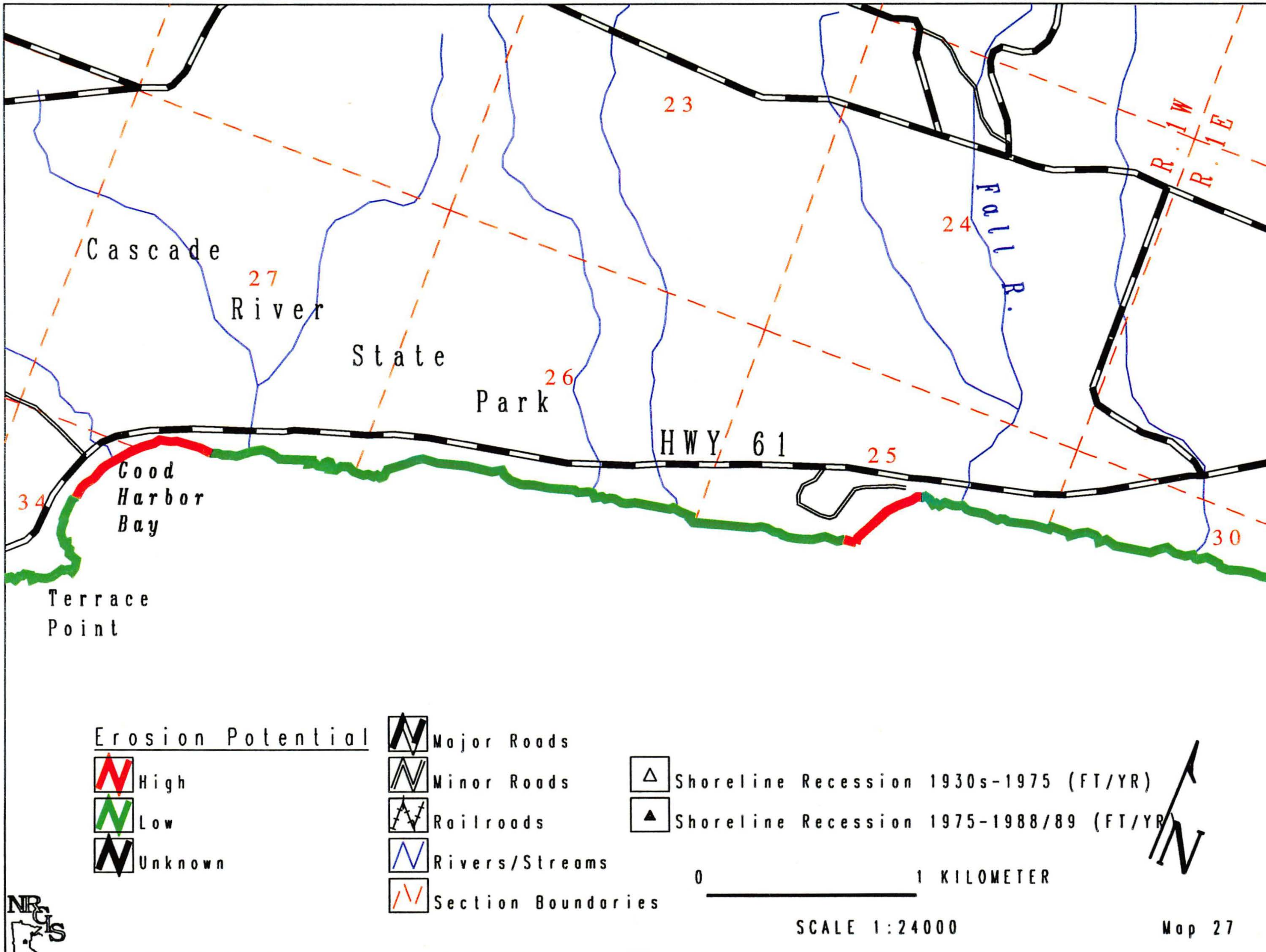

13
23
Alfred Cr.
R. 3W
R. 2W
18
Spruce Cr.
24
Jonvick Cr.
17
19
25
HWY 61
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS
Map 24



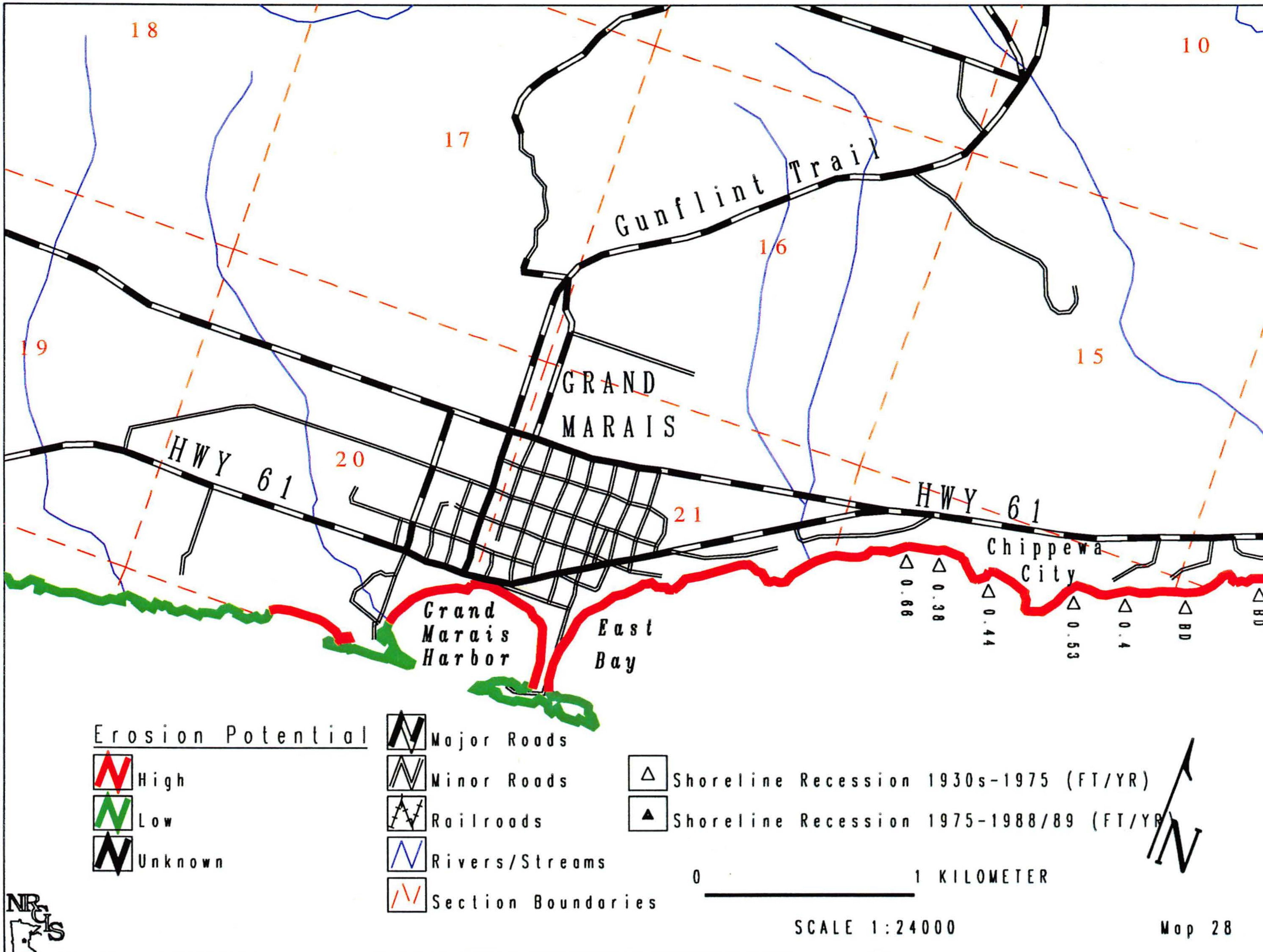
Indian Camp Cr.
T. 61N
T. 60N
35
3
9
2
Spruce Cr.
10
Cascade River State Park
16
HWY 61
BD
BD
0.48
0.69
0.93
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
N
0
1 KILOMETER
SCALE 1:24000
Map 25
NRGIS

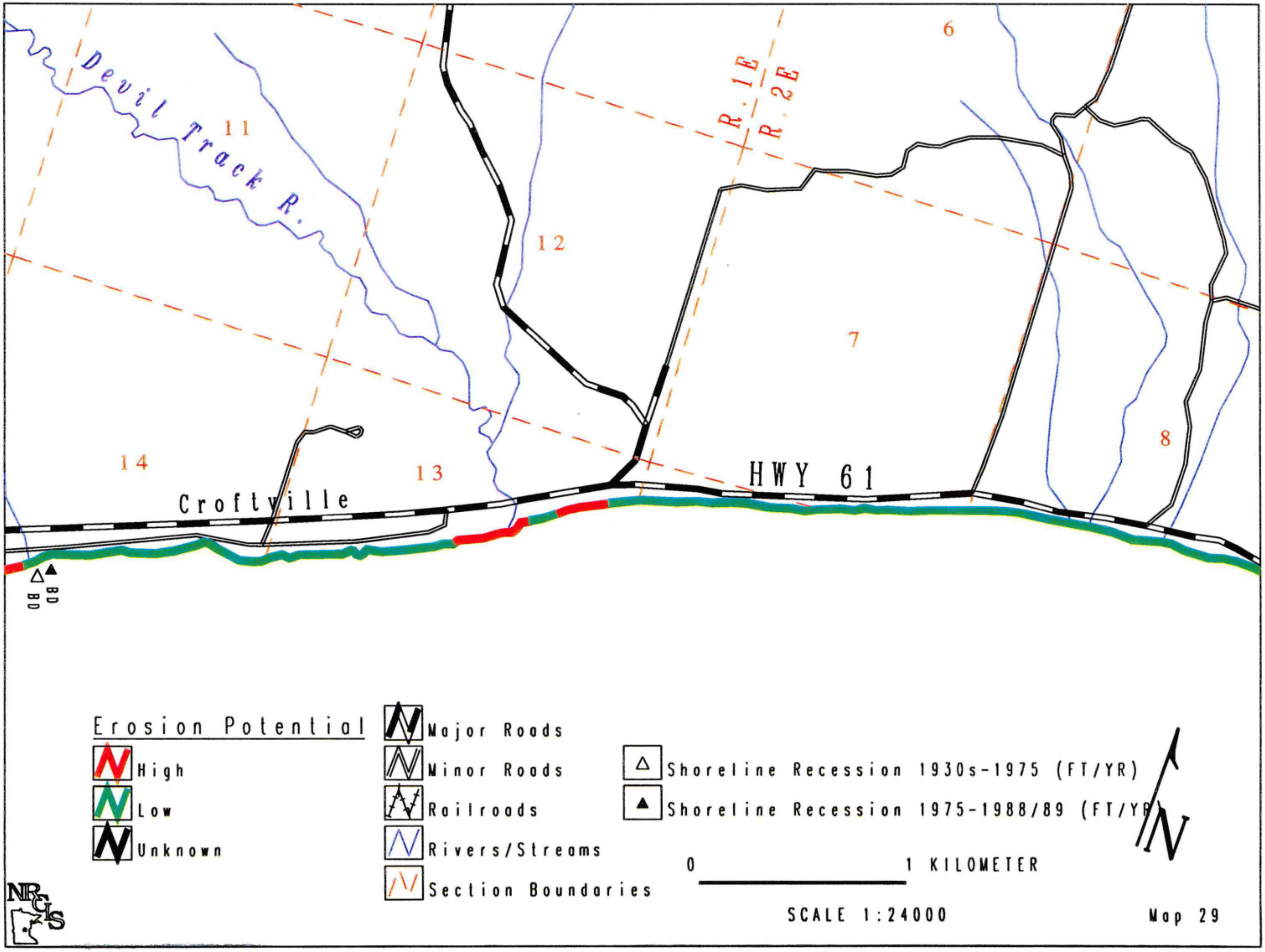


29
28
36
31
32
33
1
6
R.2W
R.1W
T.61N
T.60N
Cut Face Cr.
Cascade River State Park
HWY 61
BD
0.88
BD
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
Map 26
NRGIS
N

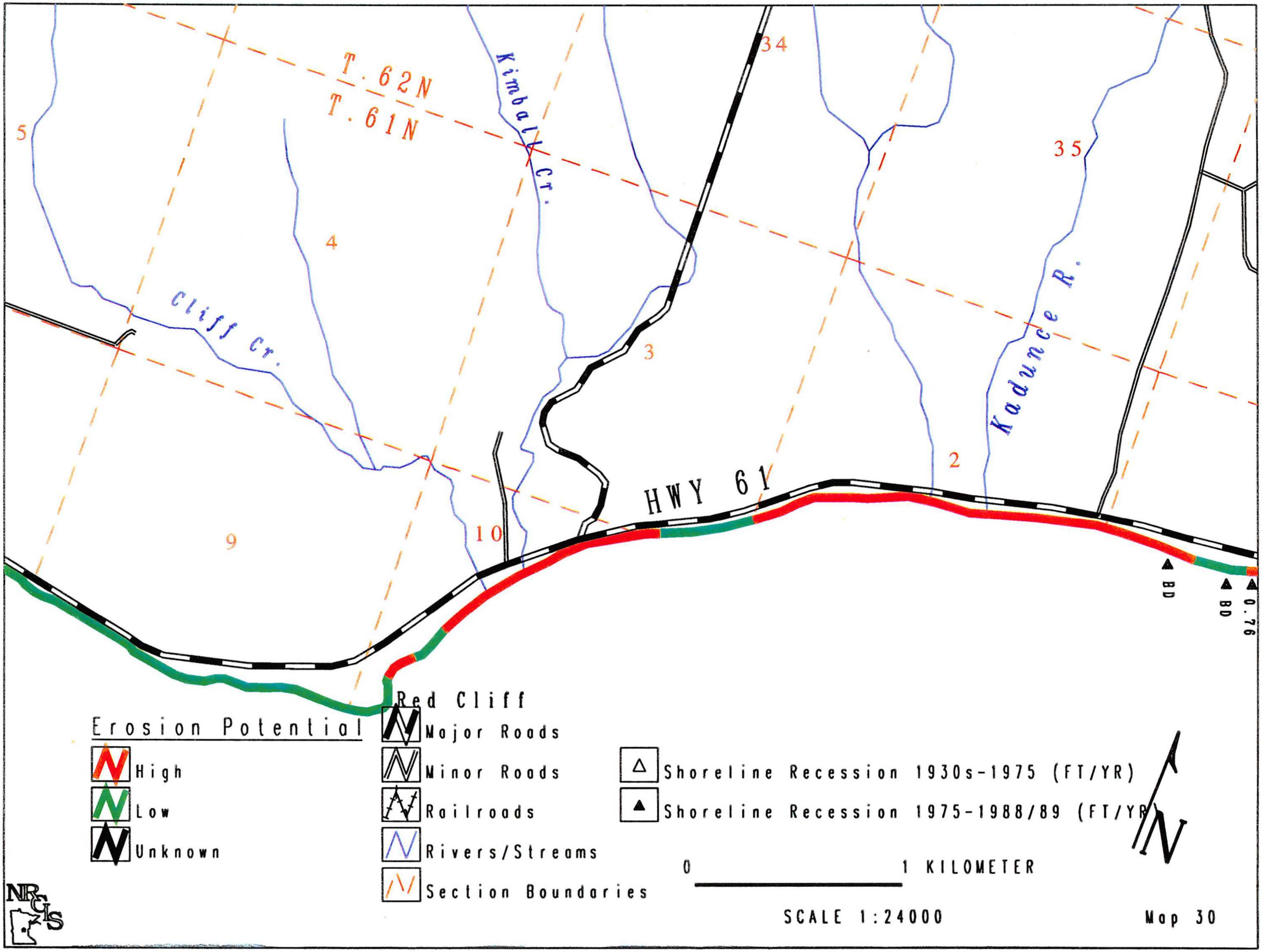


23
R. 1 W
R. 1 E
Fall R.
24
Cascade
27
River
State
26
Park
HWY 61
25
Good
Harbor
Bay
34
30
Terrace
Point
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
N
0
1 KILOMETER
SCALE 1:24000
Map 27

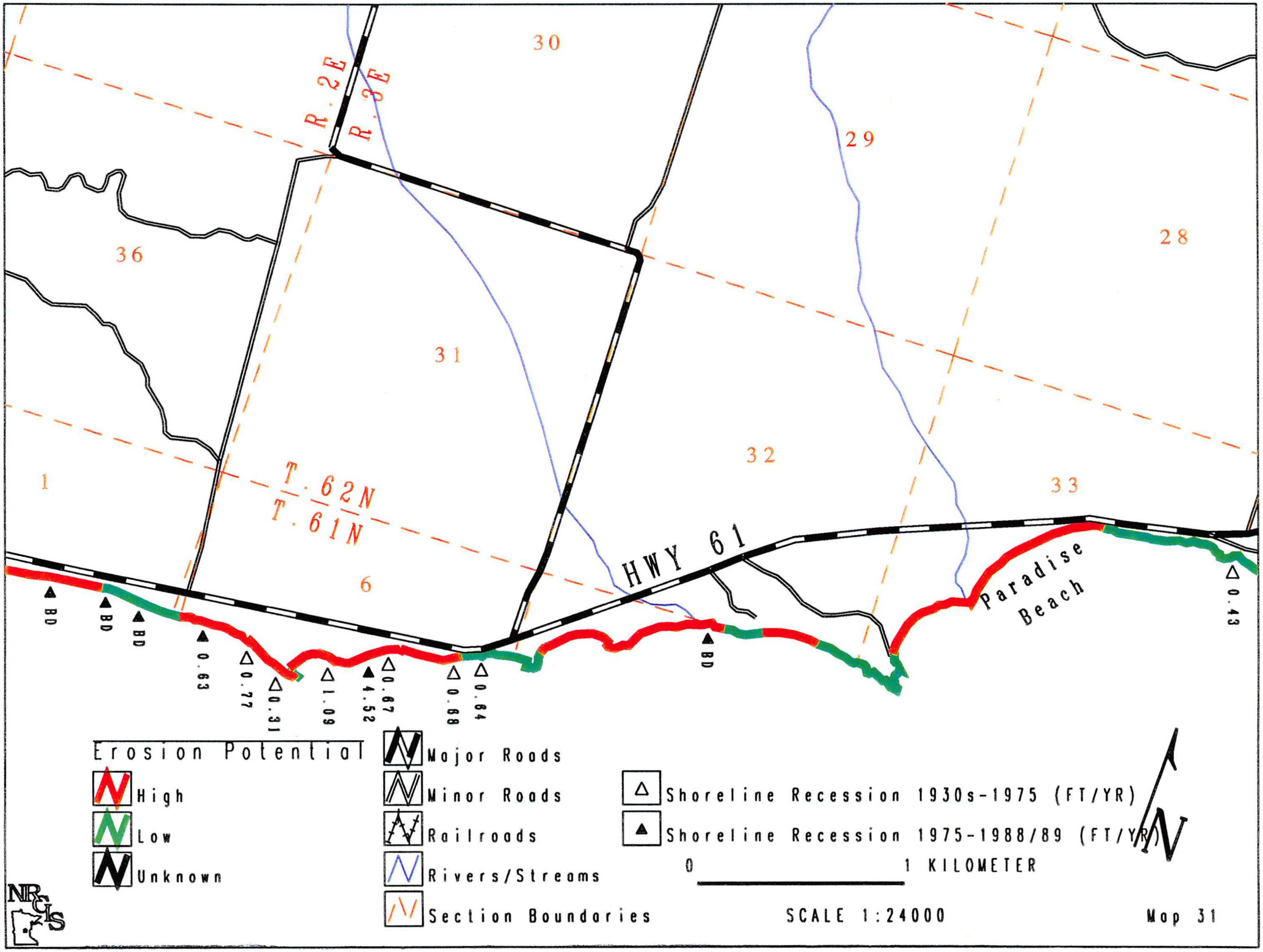

18
17
10
Gunflint Trail
16
19
15
GRAND
MARAIS
HWY 61
20
21
HWY 61
Chippewa
City
0.66
0.38
0.44
0.53
0.4
BD
BD
Grand
Marais
Harbor
East
Bay
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
N
0
1 KILOMETER
SCALE 1:24000
Map 28
NRGIS



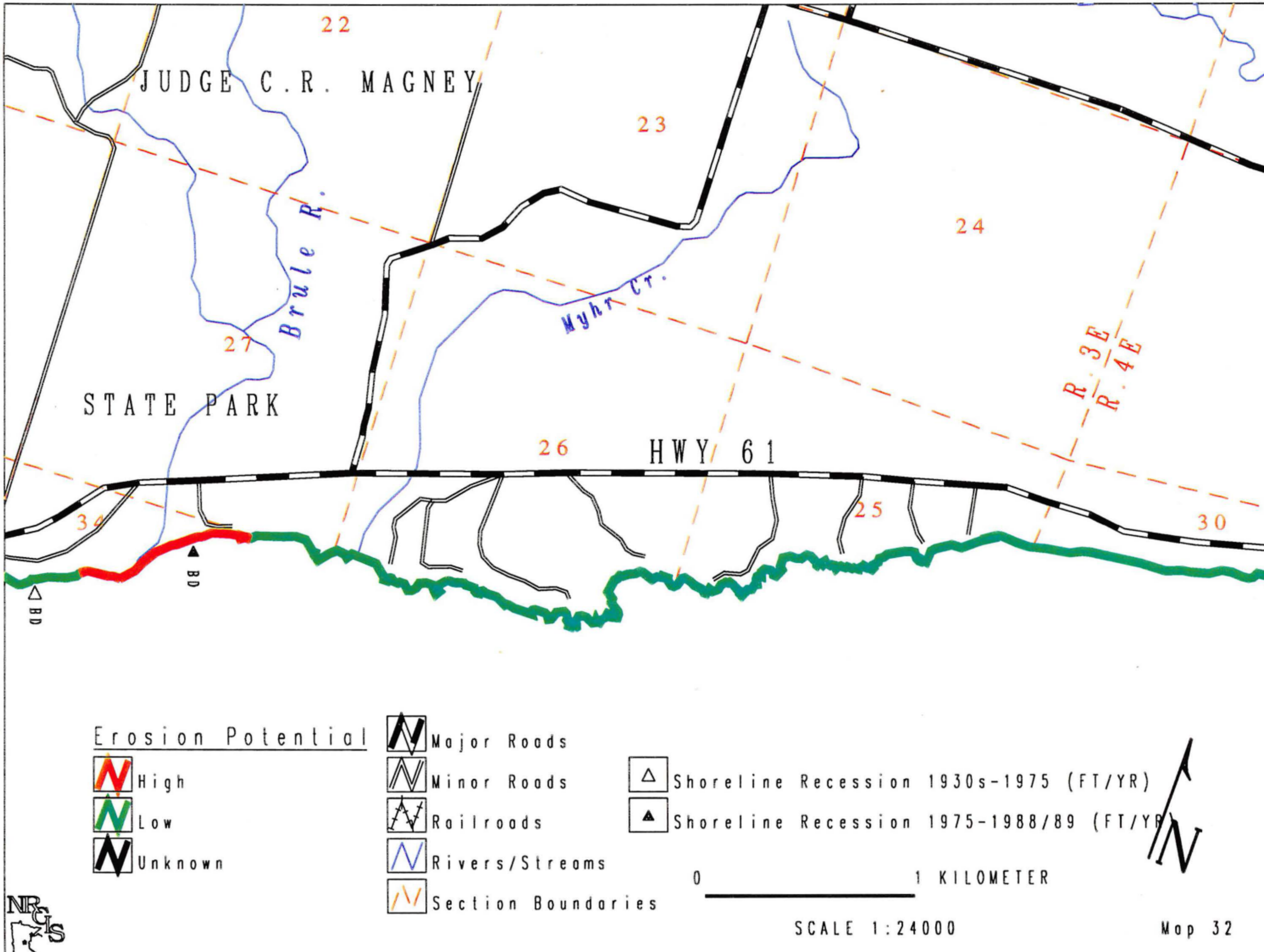
Devil Track R.
R. 1E
R. 2E
6
11
12
7
8
14
13
Croftville
HWY 61
BD
BD
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
N
0
1 KILOMETER
SCALE 1:24000
Map 29

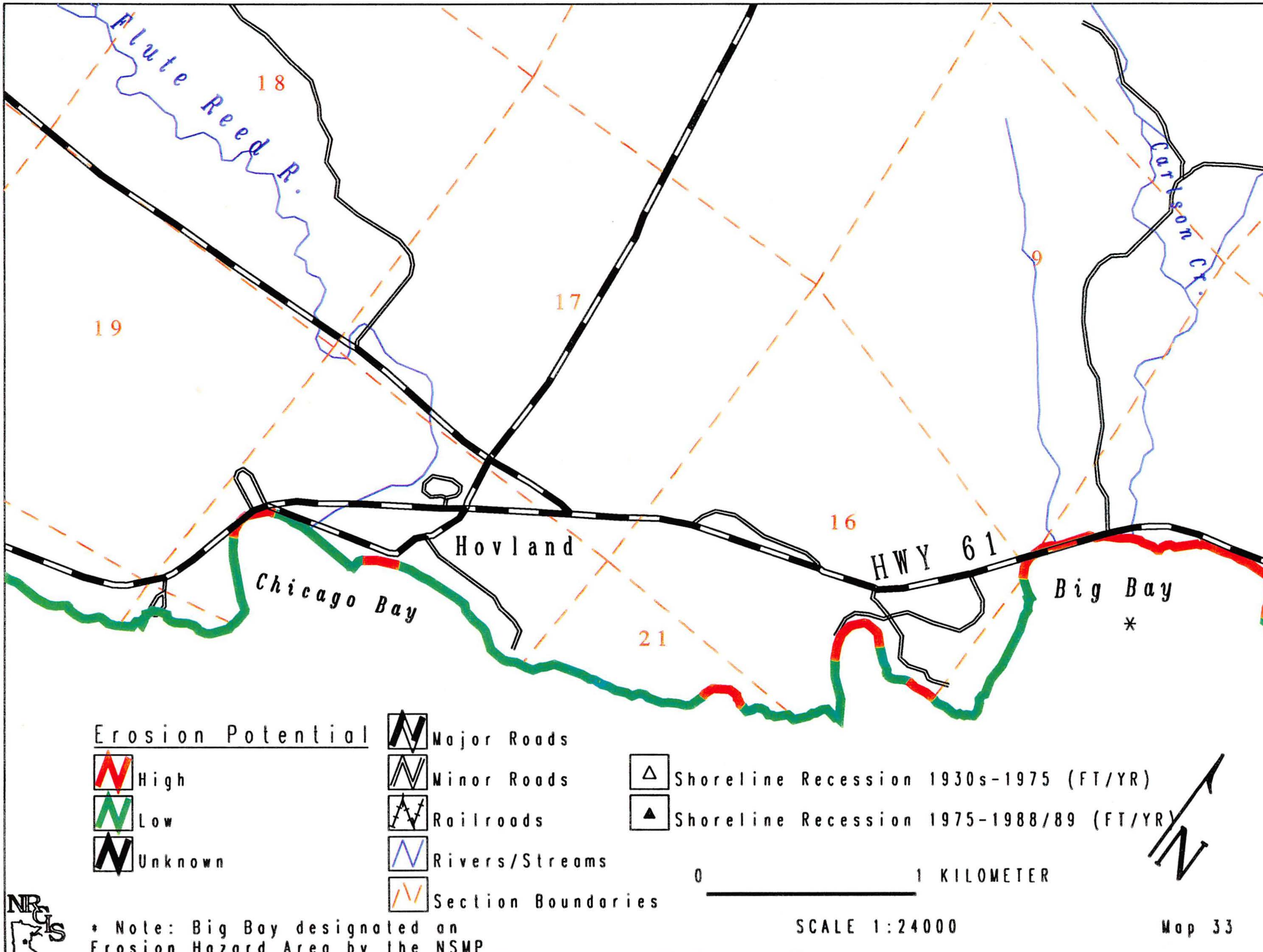


T.62N
T.61N
5
4
3
34
35
2
9
10
Kimball Cr.
Cliff Cr.
Kadunce R.
HWY 61
BD
BD
0.76
Red Cliff
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS
Map 30

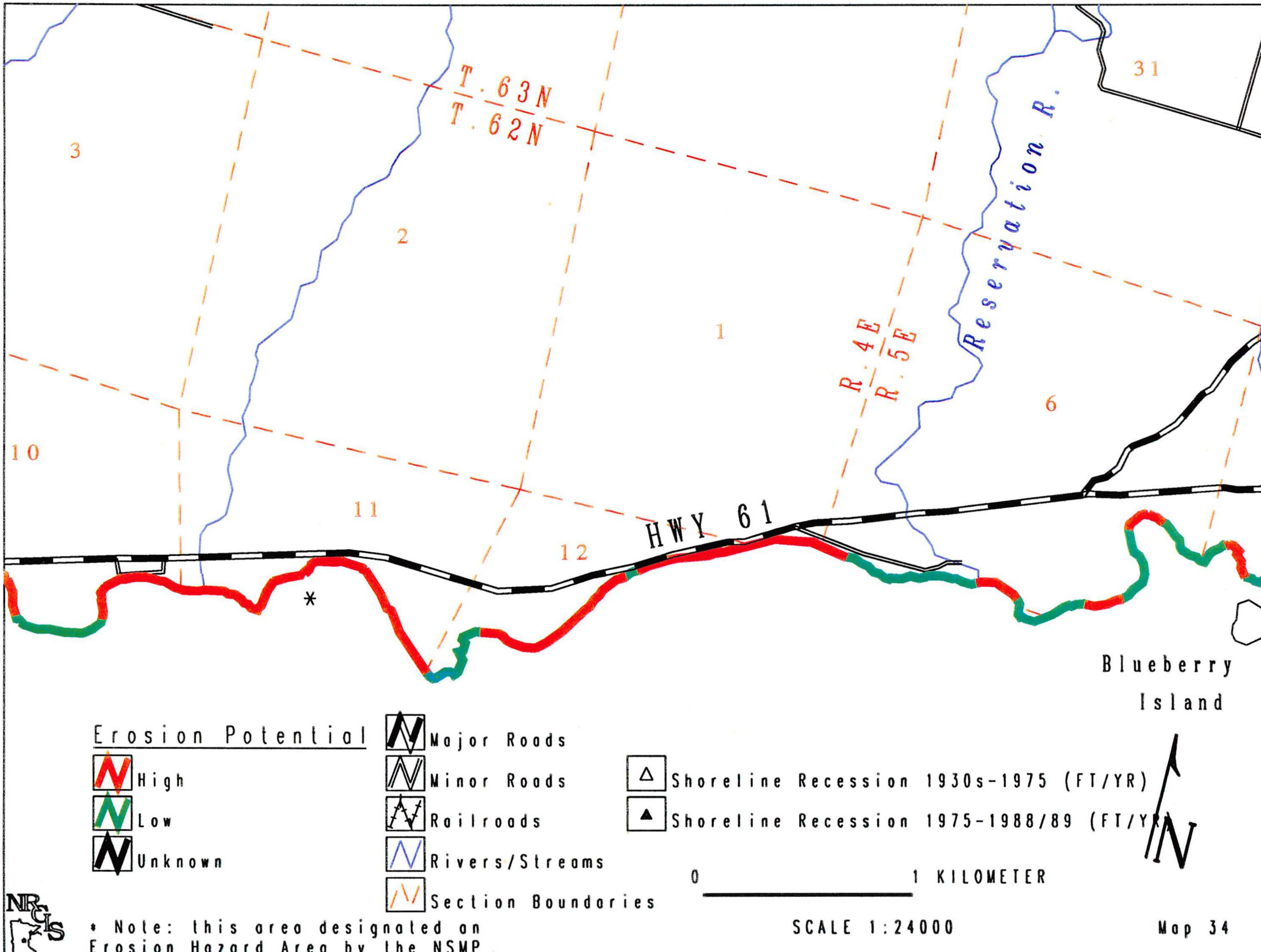


30
29
28
36
31
32
33
1
6
R. 2E
R. 3E
T. 62N
T. 61N
HWY 61
Paradise Beach
BD
BD
BD
0.63
0.77
0.31
1.09
4.52
0.67
0.68
0.64
BD
0.43
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS
Map 31

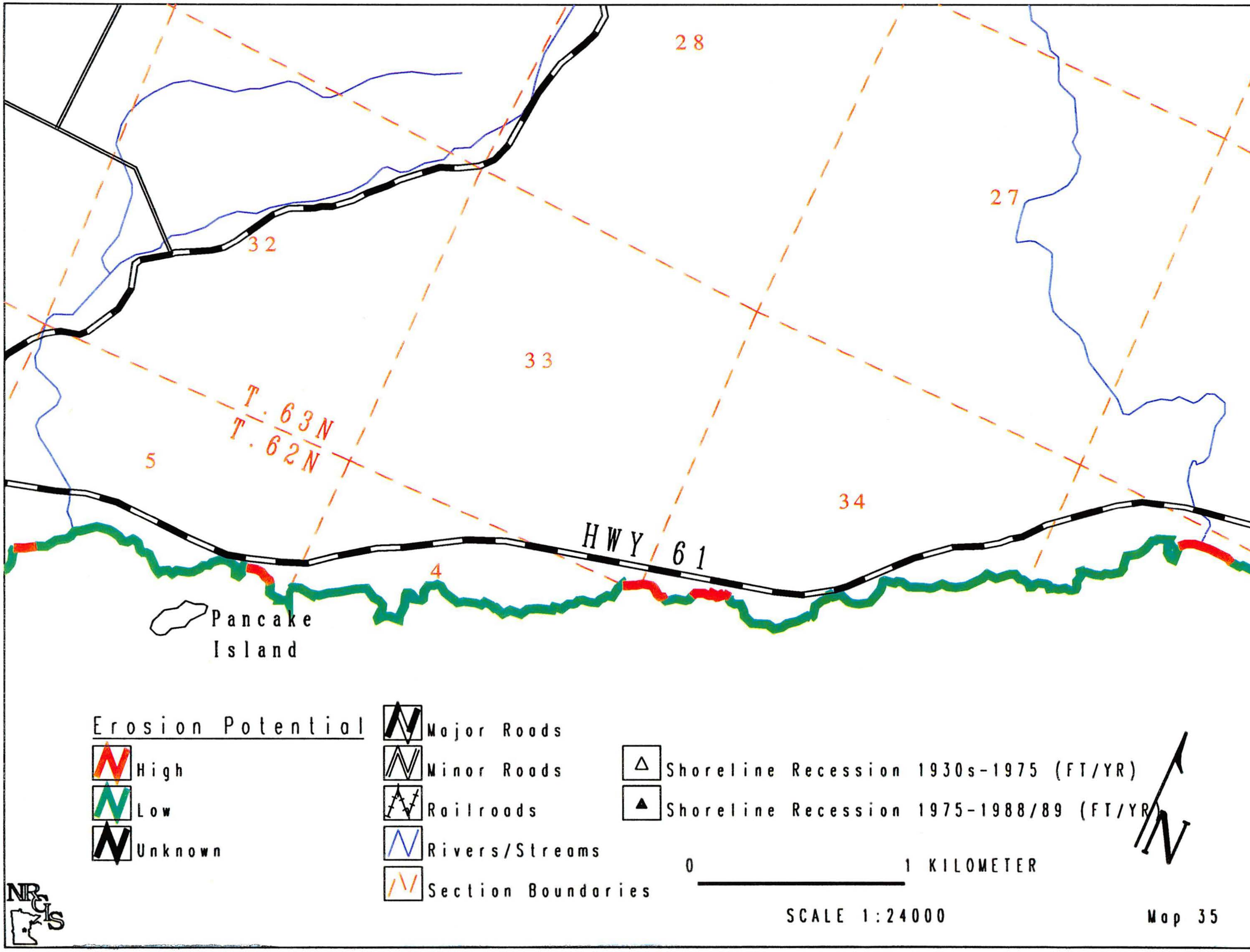

JUDGE C.R. MAGNEY
STATE PARK
Brule R.
Myhr Cr.
HWY 61
22
23
24
25
26
27
30
34
R. 3E
R. 4E
BD
BD
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
Map 32

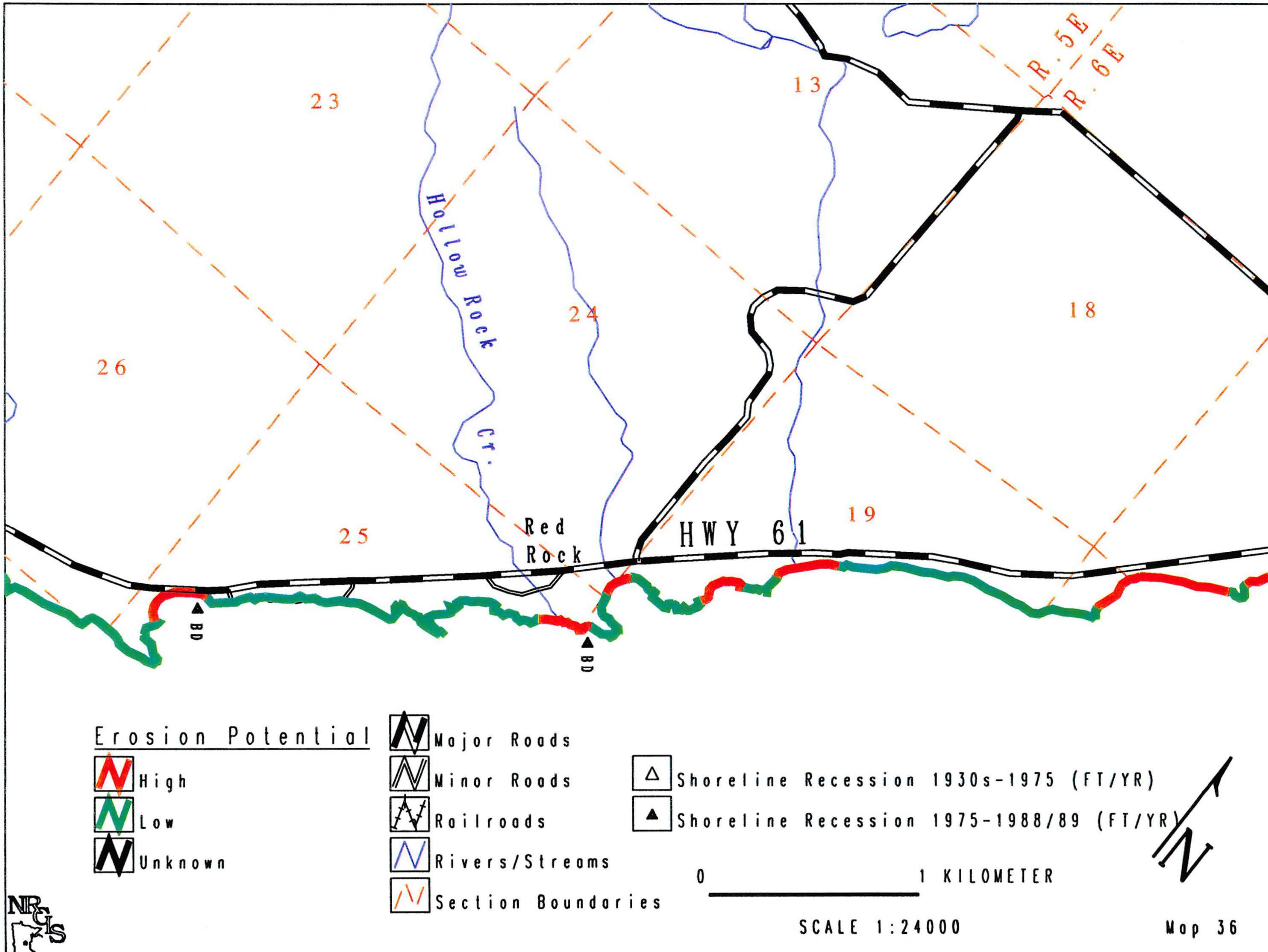


Flute Reed R.
Carlson Cr.
18
17
19
9
16
21
Hovland
HWY 61
Chicago Bay
Big Bay
*
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
N
0
1 KILOMETER
SCALE 1:24000
NRGIS
* Note: Big Bay designated an
Erosion Hazard Area by the NSMP
Map 33

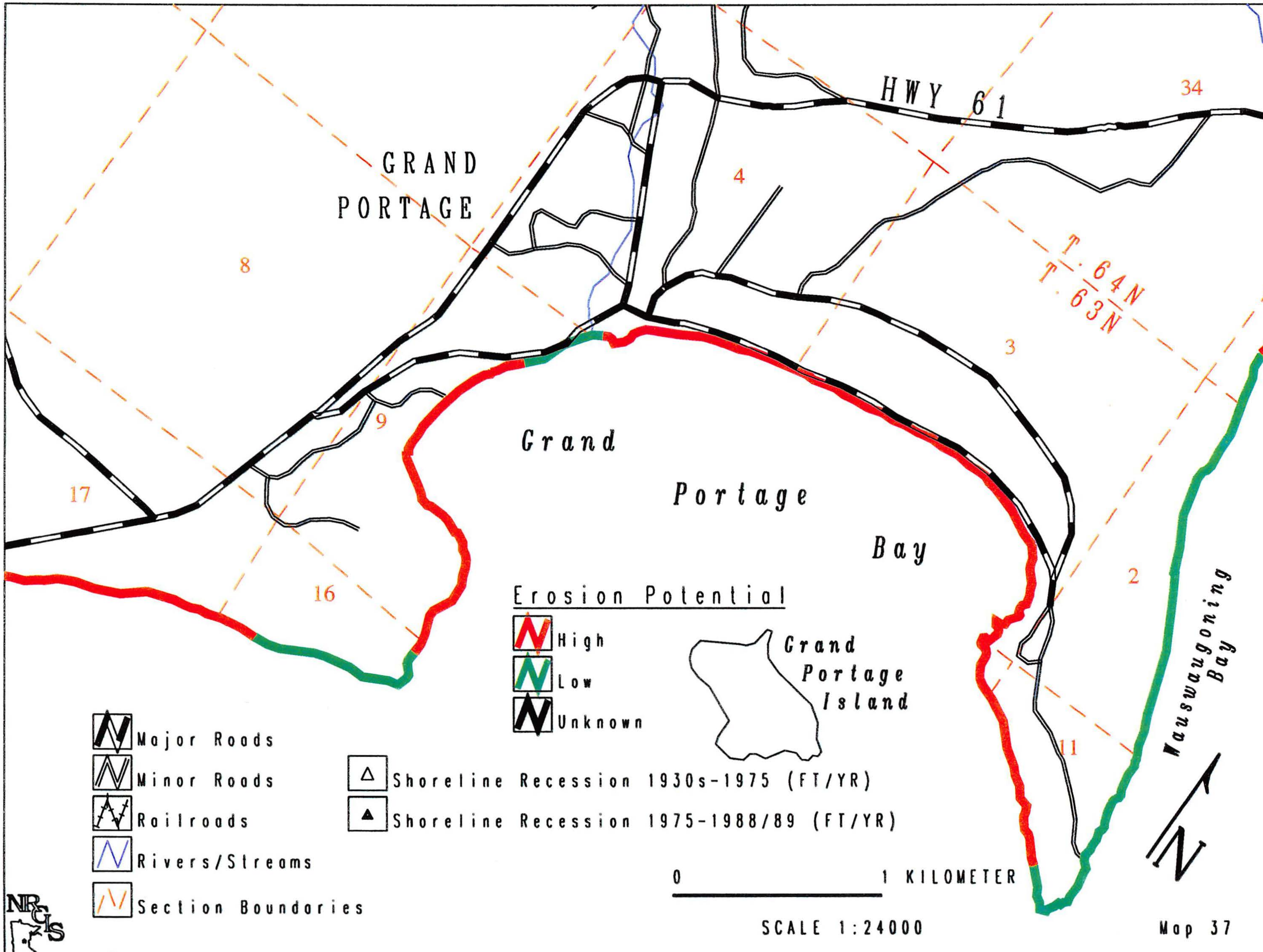


T. 63N
T. 62N
31
3
2
1
6
10
11
12
R. 4E
R. 5E
Reservation R.
HWY 61
*
Blueberry Island
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
N
NRCIS
* Note: this area designated an Erosion Hazard Area by the NSMP
SCALE 1:24000
Map 34

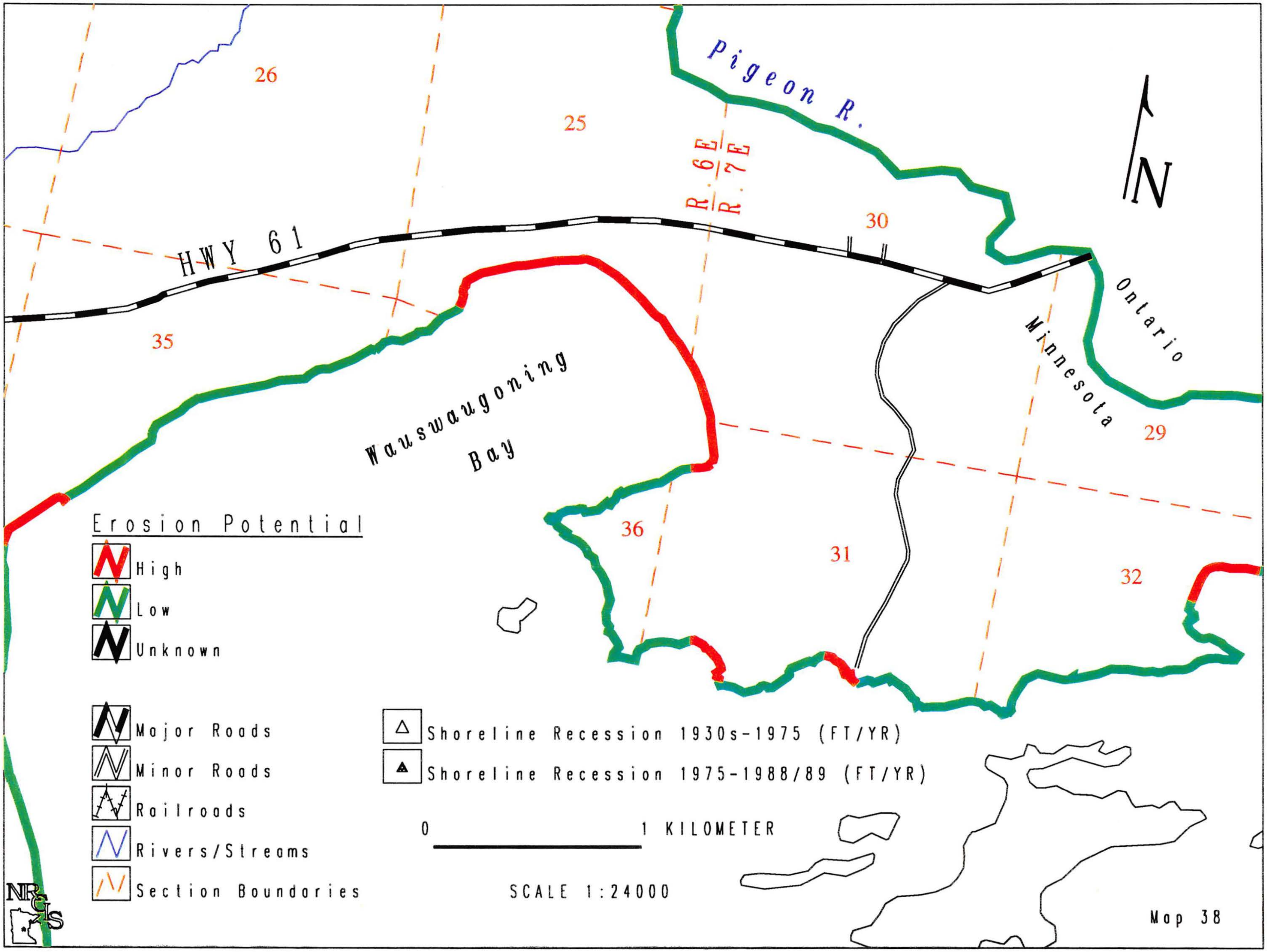

28
27
32
33
34
5
4
T. 63N
T. 62N
HWY 61
Pancake Island
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS
Map 35



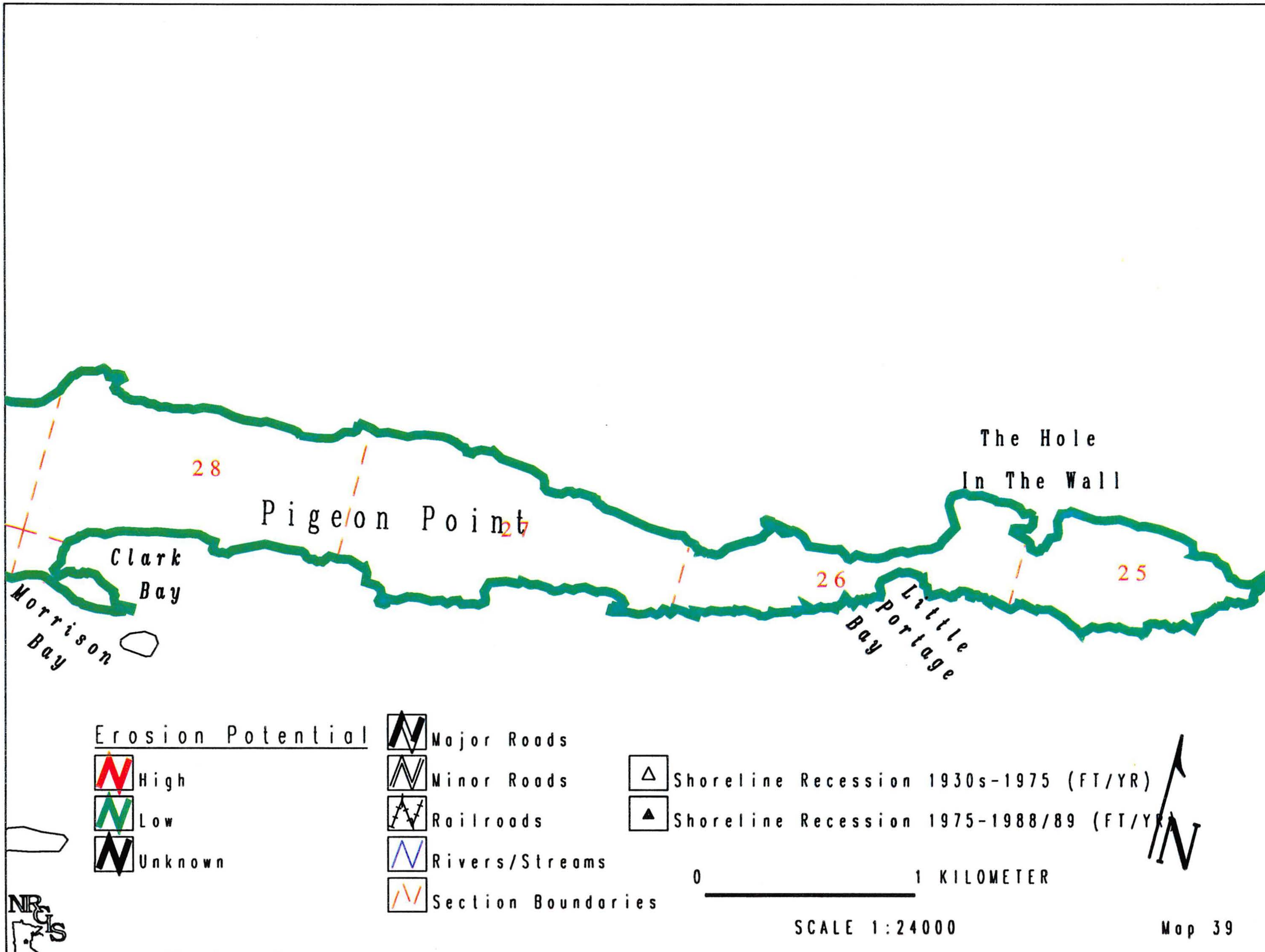
23
13
R. 5E
R. 6E
Hollow Rock
Cr.
24
18
26
25
Red
Rock
HWY 61
19
BD
BD
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS
Map 36



HWY 61
GRAND PORTAGE
34
4
8
T. 64N
T. 63N
3
9
17
Grand Portage Bay
2
16
Erosion Potential
High
Low
Unknown
Grand Portage Island
Wauswaugoning Bay
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
11
0
1 KILOMETER
SCALE 1:24000
Map 37
NRGIS



Pigeon R.
26
25
R. 6E
R. 7E
30
HWY 61
N
Ontario
Minnesota
35
Wauswaugoning
Bay
29
36
31
32
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
NRGIS
Map 38


28
27
26
25
Pigeon Point
Clark Bay
Morrison Bay
The Hole In The Wall
Little Portage Bay
Erosion Potential
High
Low
Unknown
Major Roads
Minor Roads
Railroads
Rivers/Streams
Section Boundaries
Shoreline Recession 1930s-1975 (FT/YR)
Shoreline Recession 1975-1988/89 (FT/YR)
0
1 KILOMETER
SCALE 1:24000
N
NRGIS
Map 39